Chapter 5
SOLUTION DEVELOPMENT

In moving from issue identification/analysis to solution development, seven water source options were identified to address the water supply needs in the LWC Planning Area. These options either make additional water available from historically used sources or other sources (e.g., the Floridan aquifer), or provide additional management of the options (e.g., conservation). The options are as follows (no implied priority):

1. Conservation
2. Ground Water
   - Surficial Aquifer System (SAS)
   - Intermediate Aquifer System (IAS)
   - Floridan Aquifer System (FAS)
3. Reclaimed Water
4. Regional Irrigation System
5. Seawater
6. Storage
   - Aquifer storage and recovery
   - Regional and local retention
   - Reserviors
7. Surface Water

Development of each of these options could have regional, as well as local responsibilities.

WATER RESOURCE DEVELOPMENT AND WATER SUPPLY DEVELOPMENT

Chapter 373, F.S., requires water supply plans include a list of water source options for water supply development for local water users to choose from. For each source option listed, the estimated amount of water available for use, the estimated costs, potential sources of funding, and a list of water supply development projects that meet applicable funding criteria are required. In addition, water supply plans must also include a listing of water resource development projects that support water supply development. For each water resource development project listed, an estimate of the amount of water to become available, timetable, funding, and who will implement the project, should be provided. These amendments were passed in 1997. These requirements are addressed in Chapters 5 and 6.

The statute defines water resource development and water supply development as follows:

> ‘Water resource development’ means the formulation and implementation of regional water resource management strategies, including the collection and evaluation of surface water and ground water data; structural and nonstructural programs to protect and manage water resources; the development of regional water resource implementation programs; the construction, operation, and maintenance of major public works facilities to provide for flood control, surface

> and underground water storage, and ground water recharge augmentation; and related technical assistance to local governments and to government-owned and privately owned water utilities.

and,

> ‘Water supply development’ means the planning, design, construction, operation, and maintenance of public or private facilities for water collection, production, treatment, transmission, or distribution for sale, resale, or end use.

The categorization of projects as water resource development or water supply development has received both water management district and statewide attention. Water management district budget decisions and state funding responsibilities will be influenced by how these terms are implemented. Interpretation of these terms in the water supply planning process will be driven by considerations from many forums, including the Governor's Office, the legislature, the Florida Department of Environmental Protection (FDEP), other water management districts, and stakeholder groups, such as the Lower West Coast Water Supply Plan Advisory Committee.

For the purposes of this report, it was concluded the water management district is responsible for water resource development to attain the maximum reasonable-beneficial use of water; to assure the availability of an adequate supply of water for all competing uses deemed reasonable and beneficial; and to maintain the functions of natural systems. Local users have primary responsibility for water supply development and choosing which water source options to develop to best meet their individual needs. For an option to be a water resource development project it should have the following characteristics:

- Has the opportunity to address more than one resource issue
- Addresses a variety of use classes (e.g., environment, PWS)
- Protects/enhances resource availability for allocation
- Moves water from water surplus areas to deficit areas
- Has a broad application of technology

For an option to be a water supply development project, it should have the following characteristics:

- Localized implementation of technology
- Delivery of resource to consumer
- Regionalized interconnects to consumer

The water source options were reviewed to assess their potential on a regional scale of meeting the water supply needs of the region (**Table 4**). The table indicates the ability of that option to meet the identified need, except for the inland environmental needs. For inland environmental needs, the response shows the ability of that option to offset demands, primarily from the Surficial Aquifer System (SAS), that could potentially cause drawdowns that are harmful to these natural systems. The relative ability of each

Table 4. Potential of Water Source Options in Meeting 2020 Lower West Coast Water Supply Needs.

	LWC Water Supply Needs				
Water Source Option	**Public Water Supply**	**Urban Irrigation Demands**	**Agricultural Irrigation Demands**	**Freshwater Needs of Estuarine Systems**	**Inland Environmental Needs**
Conservation	L	L	L	N/A	L
Ground Water					
Surficial Aquifer System	M	M	H	N/A	L
Intermediate Aquifer System	M	L	H	N/A	M
Floridan Aquifer System	H	L	L	N/A	H
Reclaimed Water	L	M	L	N/A	H
Regional Irrigation System	L	H	L	N/A	H
Seawater[a]	L	L	L	N/A	L
Storage					
Aquifer Storage and Recovery	M	M	M	H	M
Regional and Local Retention	M	M	M	H	H
Reservoirs	M	M	M[b]	H[b]	L
Surface Water	M	M	H	H	L

a. Not cost-effective at this time.
b. Caloosahatchee Basin only.
L=Low; M=Medium; H=High; N/A=Not Applicable.

source option in this table was based on regional volumes (supply and demand), and does not in all cases reflect the advisory committee's sense of importance of that option. For example, significant emphasis was placed on the importance of conservation and the development of a conservation ethic, although from a regional perspective, the volume of water that could be made available through conservation is relatively low compared to other water source options. At the local level, the potential of each option may change based on the specific needs of that local situation. Elements of conservation are incorporated with the use of each of these options.

These options can be considered a menu that local water users should consider using to meet their individual water needs. In many cases, several options will be used to meet the demands depending on the specific situation.

WATER SOURCE OPTIONS AND STRATEGIES

Each water source option was discussed to identify its potential for use in the LWC Planning Area. For each option, the following information is presented: definition and discussion, estimated costs to develop that option, the quantity of water potentially available from that option, and water resource development (regional) and water supply development (local) recommendations to facilitate development of that option.

Conservation

Definition and Discussion

This option incorporates water conservation measures that address demand reduction, including practices that achieve long-term permanent reductions in water use. The other water source options in this chapter make additional water available through new sources or storage. However, elements of conservation are incorporated in each of the other water source options. For example, the use of reclaimed water could be used to replace existing use of potable water or ground water for irrigation, resulting in reduced demands on these sources.

Establishing a water conservation goal or conservation ethic for this plan was discussed. One suggestion was to establish a per capita water use maximum figure that all utilities would have to meet. It was questioned how this use number would be determined, how would it be implemented, and does it actually decrease the water used. The experience of some of committee members suggests that on the whole, a reduction in per capita use is not realized because people switch to sources of water other than public water supply (PWS). Another option discussed was to establish an annual percent reduction in per capita water use. It was agreed that a comprehensive water conservation program that promotes cultivation of a conservation ethic should be implemented. This ethic would be realized through proactive, cooperative efforts between water users, utilities, local governments, and the District. The conservation program should incorporate many initiatives, including continued development and compliance with water conservation ordinances, development and implementation of effective public education programs, use of alternative water sources, and other means. This program should encompass all use types, as well as indoor and outdoor uses. Consideration of Xeriscape™ principles should be included. Less water intensive landscaping should be promoted through compliance with District Consumptive Use Permitting (CUP) conditions, Developments of Regional Impact (DRI) review, and local government compliance with new and existing ordinances and land use regulations. Retrofit measures will be evaluated with the other options and implemented as deemed appropriate.

Other discussions explored whether advanced levels of water conservation should be implemented beyond current mandatory requirements regardless of the cost or whether advanced levels should be considered as a tool or source option to be evaluated with other source options to meet the water needs of the area. It is recommended the District create a water conservation coordinator position to assist water users in evaluating water conservation.

Mandatory Requirements

The District's CUP rules require submission of a water conservation plan for each water use type. The water conservation plans must incorporate the following elements: public water suppliers (irrigation hours ordinance, Xeriscape™ landscape ordinance, ultra-low volume fixture ordinance, rain sensor device ordinance, water conservation-based rate structure, leak detection and repair program, public education program, reclaimed water feasibility); commercial/industrial users (water use audits, employee water conservation awareness programs, implementation of cost-effective conservation measures); landscape and golf course users (Xeriscape™ landscaping, rain sensor devices, irrigation hour limitations); and agricultural users (micro irrigation systems for new citrus and container nursery projects). In addition to these CUP requirements, conservation requirements are also incorporated in the Recommended Orders for DRI.

The implementation status of the conservation elements within regional PWS service areas in the LWC Planning Area is indicated in **Table 5**. Depending on the demographics and location of the service area, utilities can choose to demonstrate which water conservation activities are more cost-effective for their situation and emphasize implementation of those activities in their conservation plan.

Four of the mandatory water conservation elements require adoption of an ordinance by local governments. Generally, because of the home rule autonomy of local governments in the LWC Planning Area, each ordinance has to be adopted by each unit of local government for the measure to be fully implemented. Positive responses in the table reflect the adoption of the appropriate ordinance by the applicable local government. For investor owned utilities (private) who do not have the authority to pass ordinances, the response in the table reflects the adoption of the appropriate ordinance by the local government who has jurisdiction in that utility's service area. Utilities are not required to have a leak detection program if their unaccounted for water is less than 10 percent. An integrated program between the CUP Program and local ordinances is created when local governments have adopted the ordinances and established a compliance program.

Table 5. Implementation Status of Mandatory Water Conservation Measures.

Area	Ordinance Required				Ordinance Not Required			
	Irrigation Hours	Xeriscape / Landscape	Ultra Low Vol. Plumbing Fixture	Rain Sensor Device	Conservation Rate Structure	Utility Leak Detection /Repair	Water Conservation Public Education	Reclaimed Water Feasibility
Lee County								
Lee County Utilities	Yes	No	Yes	No	Yes	Yes	Yes	Yes
Bonita Springs	Yes	No	Yes	No	Yes	Yes	Yes	Yes
Island Water Assoc.	Yes	Yes	Yes	No	Yes	Yes	Yes	No
City of Fort Myers	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes
Greater Pine Island	Yes	No	Yes	No	Yes	No	Yes	No
Cape Coral	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Gulf Corkscrew/San Carlos	Yes	No	Yes	No	Yes	Yes	Yes	Yes
Lehigh	Yes	No	Yes	No	Yes	No	Yes	Yes
Collier County								
Immokalee	No	Yes	Yes	Yes	Yes	No	Yes	Yes
Naples	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Marco Island Utilities	No	Yes	No	Yes	No	Yes	Yes	Yes
Golden Gate	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Everglades City	Yes	No	No	Yes	Yes	No	No	Yes
Collier County Utilities	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Port of the Islands	No	Yes	Yes	Yes	No	No	Yes	No
Hendry County								
Clewiston	No	No	No	No	No	Yes	No	Yes
LaBelle	No	No	Yes	No	No	Yes	No	Yes
Port LaBelle	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
Glades County								
Moore Haven	No	Yes	Yes	No	No	Yes	No	No
Charlotte County								
No Public Water Supply Systems in Planning Area								

Supplemental Measures

There are also several supplemental water conservation measures that local users could implement if they deem any of the measures to be cost-effective. Measures for urban users include indoor and outdoor retrofits and landscape audit and retrofit; PWS utilities include filter backwash recycling and distribution pressure control; and agricultural users include irrigation audits and improved scheduling, and retrofitting with a micro irrigation system.

Mobile Irrigation Labs

Mobile Irrigation Labs (MIL) are usually identified as agricultural MILs or urban MILs. Urban labs typically serve landowners with less than 10 acres of irrigated lands. These labs conduct performance evaluations for both agricultural and urban irrigation systems free of charge as a public service. The objective of the MIL program is twofold: water conservation and public education. These labs provide outreach and education to the public while not invoking a regulatory stance.

There are currently two MILs in the LWC Planning Area. An agricultural lab is headquartered at the Collier Soil and Water Conservation District (SWCD) and serves Lee, Hendry, Collier, Glades, and Charlotte counties. This lab also performs some urban evaluations. The other lab is headquartered at the Lee SWCD and performs urban evaluations. Funding for these labs has been provided by the District and the Natural Resource Conservation Service (NRCS). However, the District is eliminating their financial involvement by June 2000. Other potential funding sources are being identified, such as the Florida Department of Agriculture and Consumer Services (FDACS). The annual operating cost for an urban MIL is approximately $70,000 and $130,000 for an agriculture MIL.

Both of these labs are working at their maximum potential in terms of the number of evaluations that can be performed in a year. A backlog of several months exists for both MILs. As a result, it is recommended that a separate agricultural MIL be established at the Lee SWCD to assist the existing lab at the Collier SWCD. In addition, because of the existing and projected urban needs, it is also recommended an urban MIL be established for Collier County at the Collier SWCD. Dedicated sources of funding need to be established for the existing, as well as, the recommended MILs.

Cost-Effectiveness Analysis of the FY 1998 LWC MIL Program. The costs and potential water savings contained in the 1998 annual reports for each lab located in the LWC Planning Area are presented in **Table 6**.

Table 6. 1998 Lower West Coast MIL Cost and Estimated Water Savings.

Lab	Annual Cost	Potential Water Savings (1,000 gallons per year)	Total Cost (per 1,000 gallons)
Urban (Fort Myers)	$70,000	79,500	$.88
Agriculture (Naples)	$130,000	1,470,000	$.09
Total	$200,000	1,549,500	$.13

The cost-effectiveness and water savings will be magnified to the degree that cost savings from a single mobile lab visit extend over several years. Another environmental benefit of the urban and agricultural MIL program is the reduction of pollution from fertilizers and pesticides applied to urban landscapes and cropland. One of the key components of the MIL program, education, is not illustrated in the above tables.

Conservation Estimated Costs

The information in this section should not be interpreted as a benefit-cost analysis of these conservation measures, since no discounting is applied.

Urban Conservation Measures

Cost and water savings for several indoor and outdoor urban retrofit water conservation measures are provided in **Tables 7** and **8**.

Table 7. Representative Water Use and Cost Analysis for Retrofit Indoor Water Conservation Measures.

	Toilet	**Showerhead**
Cost/unit ($)	$200	$20
Flushes/day/person	5	--
Gallons saved/flush	1.9	--
Minutes/day/person	--	10
Gallons saved/minute	--	2
Persons/unit	2.5	2.5
Life (years)	40	10
Savings/year/unit (gallons)	8,670	9,125
Savings/unit over life (gallons)	346,800	91,250
Cost/1,000 gallons saved	$0.58	$0.22

Table 8. Representative Water Use and Cost Analysis for Retrofit Outdoor Water Conservation Measures.

	Rain Sensor
Cost/unit ($)	$68
Acres/unit	0.11
Water savings (inches/year)	70
Water savings (gallons/year)	209,070
Life (years)	10 years
Water savings/life (gallons)	2,090,700
Cost/1,000 gallons saved ($)	$0.033

Existing urban conservation efforts have resulted in significant water savings throughout the District. A review of per capita water use rates for PWS systems that have CUP allocations of 4,000 MGY or greater, and quantification of water savings as a result of reductions in per capita water use rates, indicates substantial water savings have been realized Districtwide. From 1988 to 1995, it is estimated that conservation has resulted in approximately 118 MGD reduction in PWS demands Districtwide. Major water savings are anticipated for PWS systems that have CUP allocations less than 4,000 MGY as a result of conservation also. In addition to water conservation, over 130 MGD of reclaimed water is being reused.

For the urban water conservation methods, the analysis indicated the value of the savings is greater than the costs of the methods. The savings per unit of cost associated with the outdoor conservation measures are generally greater than those for indoor conservation measures, primarily because of the larger volumes of water involved per unit affected by the outdoor conservation measures. Water savings associated with implementation of retrofit programs can be significant. For example, if 10,000 showerheads were retrofitted in an area, this action could result in a water savings of 182 MGY (0.50 MGD). Likewise, if 10,000 irrigation systems were retrofitted with rain sensor devices, this modification could result in a water savings of more than 2,000 MGY (5.73 MGD).

One potential urban conservation method is for local governments to adopt ordinances limiting the number of days per week a home could irrigate, such as odd addresses can only irrigate on Mondays and Thursdays, etc. This ordinance may achieve the same results of a rain sensor retrofit program, but at a significantly less cost. With all ordinances, mechanisms to enforce them have to be established.

Agricultural Conservation Methods

Within the agricultural industry, many efforts have been initiated to use water more efficiently. Since 1993, citrus and container nursery permittees have been required to use micro irrigation or other systems of equivalent efficiency. This requirement applies to new installations or modifications to existing irrigation systems. In addition, many existing operations have been retrofitted. These activities have resulted in more than 70 percent of the citrus in the LWC Planning Area currently using micro irrigation. Conversion of the remaining acres is occurring within the industry, where appropriate. In some situations, flood irrigation provides benefits to the hydrology of isolated wetlands through an elevated water table. In other situations, conversion to micro irrigation is not appropriate because of site-specific considerations. Some vegetable farms have also converted on a voluntary basis to a micro irrigation system.

A MIL also operates in the LWC Planning Area to assist growers in identifying additional opportunities to save water, such as water table management and determining irrigation frequency and needs. Within the industry, growers have implemented management practices that meet or exceed permitting requirements and agree favorably with University of Florida, Institute of Food and Agricultural Sciences (IFAS), recommendations. Conversion of existing flood irrigated citrus to micro irrigation is another potential source of water savings (**Table 9**). It is estimated by UF-IFAS that the initial cost to install a micro irrigation system on citrus is $1,000 per acre and the system would have estimated annual maintenance costs of $25 per year (IFAS, 1993).

Table 9. Irrigation Costs and Water Use Savings[a] Associated with Conversion from Flood Irrigation to Micro Irrigation.

Initial cost ($/acre)	$1,000
Operating cost ($/acre)	$25
Water savings (inches/year)	8.519
Water savings (gallons per year)	230,805
Life (years)	20
Cost over life ($)	$1,500
Water savings over life	4,616,100
Cost/1,000 gallons saved ($)	$0.33

a. Addresses reductions in pumpage only and does not include return flow.
Source: IFAS and SFWMD.

The table summarizes the cost and potential water savings from one acre of conversion. This comparison used the modified Blaney-Criddle formula, and the only variable that changed between the two scenarios was the efficiency factor. Return flow for flood irrigation was not accounted for. The water savings from converting 25,000 acres of citrus from flood irrigation with a 50 percent efficiency to micro irrigation with an 85 percent efficiency could result in a water savings of approximately 6,000 MGY (15.8 MGD). The analysis illustrates that given the large volumes of water used for irrigation by agriculture, water conservation savings (which can be achieved at a reasonable cost) can be cost-effective compared to the costs of developing additional water supplies.

In addition to the water savings associated with conversion of flood irrigated citrus to micro irrigation, IFAS also has indicated that prescriptive applications of water and fertilizer can be made throughout the crop growing season with micro irrigation. However, micro irrigation systems generally have greater maintenance requirements than flood irrigation systems.

Quantity of Water Potentially Available from Conservation

Urban

Existing urban conservation efforts have resulted in significant water savings throughout the District. A review of per capita water use rates for PWS that have CUP allocations of 4,000 MGY or greater, and quantification of water savings as a result of reductions in per capita water use rates, indicates substantial water savings have been realized Districtwide. From 1988 to 1995, it is estimated that conservation has resulted in approximately 118 MGD reduction in PWS demands Districtwide. Major water savings are anticipated for PWS systems that have allocations of less than 4,000 MGY as a result of conservation also. In addition to water conservation, over 130 MGD of reclaimed water is being reused.

A 10 percent reduction in projected PWS and residential self-supplied water use from the late 1980s and early 1990s per capita uses is estimated with implementation of the appropriate mandatory conservation elements through the planning horizon. This equates to about a 17 MGD in water savings over the 20-year planning horizon. There are also retrofit opportunities in urban areas. In urban areas, the following water savings could occur per 10,000 units installed: toilet, 0.24 MGD; showerhead, 0.50 MGD; and rain sensor devices, 5.73 MGD.

Many of the urban retrofit measures need to be evaluated at the local level (water supply development). For example, utilities that have high outdoor water use may want to implement an incentive program to install rain sensor devices on existing irrigation systems. Utility per capita water use rates can be used to indicate where outdoor water use with potable water is occurring. It is recommended urban retrofit water conservation is one of several water source options that should be evaluated by the local utility/ government to meet existing and projected demands. A mandatory retrofit program is not recommended at this time.

Agriculture

Retrofitting the approximately 35,000 remaining acres of citrus that currently use flood irrigation to micro irrigation could result in a reduction in water use of up to 20 MGD. Approximately 95,000 acres currently use micro irrigation. It is recognized that conversion of existing flood irrigation systems to micro irrigation is occurring within the industry, where appropriate. It was stated that micro irrigation is not applicable in all cases because of water quality and other site specific considerations. As a result, it is recommended retrofitting of existing flood irrigation systems be done on a project-by-project basis, in addition to implementing Best Management Practices (BMPs). New citrus operations are required to install micro irrigation systems.

Overall

Additional water savings will be achieved through implementation of a comprehensive water conservation program that promotes cultivation of a conservation ethic. This ethic would be realized through proactive, cooperative efforts between water users, utilities, local governments, and the District. The comprehensive water conservation program efforts will incorporate many initiatives, including continued development and compliance with water conservation ordinances, development and implementation of public education programs, use of alternative water sources, and other means. This plan will encompass all use types, as well as, indoor and outdoor uses. The plan will incorporate consideration of Xeriscape™ principles. Less water intensive landscaping will be promoted through compliance with District CUP conditions, DRI review, and compliance with local government new and existing ordinances and land use regulations. Retrofit measures will be evaluated with the other options, and implemented as deemed appropriate. The conservation program will be developed through public meetings.

Conservation Recommendations

The following water resource development recommendations were made regarding conservation:

1. The District will develop and implement a comprehensive water conservation program to cultivate a conservation ethic in cooperation with water users, utilities, and local governments to promote water conservation and more efficient use of the water resources in the LWC Planning Area. The conservation program will incorporate continued development and compliance with water conservation ordinances, development and implementation of public education programs, use of alternative water sources, other conservation methods, and documenting new and existing water conservation efforts. The conservation program will encompass all uses, but should provide emphasis on the outside use of water and Xeriscape™ principles. The creation of a water conservation coordinator position and provisions for fiscal incentives are envisioned as potential tools to establish the water conservation plan to cultivate a conservation ethic.

2. The District will support maintaining the existing MILs (one agricultural, one urban) and encourage establishment of two additional MILs (one agricultural, one urban) in the LWC Planning Area through identification of dedicated non-District funding sources for existing and additional MILs.

The following water supply development recommendations were made regarding conservation:

1. Utilities and local governments must consider implementation and compliance with all appropriate PWS mandatory conservation elements and ordinances, where appropriate.
2. Water users and utilities must consider implementation of higher efficiency irrigation systems and other conservation measures, where appropriate.
3. Local governments and utilities must encourage the use of alternative water sources for nonpotable uses, versus using potable water.
4. Water users, utilities, and local governments must encourage maintaining the existing MILs and establishment of two additional MILs (one agricultural, one urban) in the LWC Planning Area. Assist in identifying dedicated non-District funding sources to support the MIL Program.
5. Water users and utilities must consider evaluating the need and potential of retrofit conservation measures, in addition to other source options.
6. Local governments and utilities must consider developing and implementing water conservation public education programs in cooperation with the District.
7. Local governments must consider developing and codifying, including a compliance program, land use regulations that require installation of and maintaining of less water intensive landscaping.
8. Local governments must consider developing and codifying, including a compliance program, with water conservation ordinances.

Ground Water Resources

Three major aquifer systems exist within the LWC Planning Area. These aquifers are identified as the Surficial Aquifer System (SAS), the Intermediate Aquifer System (IAS), and the Floridan Aquifer System (FAS). Within each of these aquifers hydraulic properties and water quality may vary both vertically and horizontally; thus, the ground water supply potential varies from one area to another. This section will focus on the aquifer properties characteristic of the LWC Planning Area, and the current water supply demand and water producing capability of each aquifer.

Surficial Aquifer System

Definition and Discussion

The Surficial Aquifer System (SAS) consists of two aquifers in the LWC Planning Area: the water table and the lower Tamiami. These aquifers are easily recharged from the surface and are separated by leaky confining units over the majority of the LWC Planning Area. Wellfields using these aquifers can be limited by the rate of recharge and water movement in the aquifer, environmental impacts, proximity to contamination sources, saltwater intrusion, and other existing legal users in the area.

Water Table. The water table aquifer is a primary source in central and northern Lee County. Within Lee County, Gulf Utilities, Lee County Green Meadows and Corkscrew, and the city of Fort Myers withdraw water from the water table aquifer. Fort Myers recharges their wellfield with water from the Caloosahatchee River via a pipeline. In addition, this aquifer supplies irrigation water for some agricultural purposes. In Hendry County, production from the water table aquifer is somewhat sporadic and is used only where no other suitable alternative is available. Typically, the water quality of this aquifer is good with the exception of areas near LaBelle and near the coast. Protection of wetlands from harm is the primary limiting factor on withdrawals from the water table aquifer.

Lower Tamiami Aquifer. The most prolific source of water in Collier County is the lower Tamiami aquifer. Bonita Springs, Collier County, the city of Naples, Immokalee, North Naples, numerous domestic self-suppliers and landscape/agricultural irrigation wells withdraw water from this source. Such heavy demands are being placed on this aquifer that potential saltwater intrusion along the coast and frequent water shortage declarations are major concerns.

Surficial Aquifer System Estimated Costs

The costs related to well construction for the SAS are provided in **Table 10**. There are additional costs for water treatment for potable uses. Many of the treatment facilities in the LWC Planning Area use lime softening for surficial aquifer water. Lime softening’s cost advantages are in operating and maintenance expenses (**Table 11**), where costs are typically 20 percent less than for comparable membrane technologies. However, enhanced lime softening and membrane softening are being used by utilities to enhance or replace traditional lime softening due more stringent water quality standards. The cost of membrane softening is indicated in **Table 12**. One significant advantage over lime softening is membrane softening’s effectiveness at removing organics that function as a precursor to the formation of disinfection by-products, such as trihalomethanes.   .

Table 10. Surficial Aquifer System Well Costs[a].

Surficial Aquifer System	Drilling Cost (per well)	Equipment Cost (per well)	Engineering Cost (per well)	Operations and Maintenance Cost (per 1,000 gallons)	Energy Cost (per 1,000 gallons)
Costs	$45,000	$62,000	$16,000	$.004	$.025

a. Costs based on a 16-inch diameter well and a maximum well depth of 200 feet.
Source: PBS&J, 1991, Water Supply Cost Estimates, converted to 1999 dollars.

Table 11. Lime Softening Treatment Costs.

Facility Size	Capital Cost (per gallon/ day capacity)	Engineering Cost (per gallon/ day capacity)	Land Requirements (Acres)	Operations and Maintenance Cost (per 1,000 gallons)	Energy Cost (per 1,000 gallons)
3	$1.63	$.25	1.5	$.60	$.023
5	$1.57	$.24	2.5	$.56	$.023
10	$1.53	$.23	4.0	$.50	$.021
15	$1.26	$.19	6.0	$.41	$.020
20	$1.13	$.16	8.0	$.38	$.020

Source: PBS&J, 1991, Water Supply Cost Estimates, converted to 1999 dollars.

Table 12. Membrane Softening Costs.

Facility Size	Capital Cost (per gallon/ day capacity)	Engineering Cost (per gallon/ day capacity)	Land Requirements (Acres)	Operations and Maintenance Cost (per 1,000 gallons)	Energy Cost (per 1,000 gallons)
3	$1.67	$.25	0.40	$.55	$.200
5	$1.52	$.23	0.40	$.53	$.200
10	$1.41	$.21	0.50	$.50	$.200
15	$1.38	$.21	0.63	$.48	$.200
20	$1.33	$.20	0.78	$.46	$.200

Source: PBS&J, 1991, Water Supply Cost Estimates, converted to 1999 dollars.

Quantity of Water Potentially Available from Surficial Aquifer System

Based on the 1994 LWC Water Supply Plan analysis and information contained in Chapter 4, from a regional perspective, increases in production from the SAS along the coast beyond existing demands appears limited due to potential wetland impacts and saltwater intrusion. However, it was concluded some further development of the SAS can be accomplished in these areas at the local level through modifications to wellfield configurations and pumping regimes with respect to locations of wetlands and saltwater. Increasing storage, through aquifer storage and recovery (ASR) or regional and local retention, will also allow further development of the SAS. As a result, additional, withdrawals from the SAS in these coastal areas will have to be evaluated on a project-by-project basis in these areas.

It was further concluded that the SAS is sufficient to meet the existing and proposed SAS projected agricultural demands through 2020 in eastern Collier County and southwestern Hendry County. The volume of water that could be withdrawn by any specific user must be determined through the District's CUP Program.

Surficial Aquifer System Recommendations

The following water resource development recommendations were made regarding the SAS:

1. The District should review existing water quality and water level monitoring for the SAS aquifers in the LWC Planning Area. Well locations and parameters should be compared with areas of current and projected land use development, utilization of the aquifer, areas of existing saltwater intrusion, and areas where there is a potential for saltwater intrusion. The District's monitoring program will be maintained and should be expanded where appropriate. Emphasis should be placed on monitoring and analysis of water levels and salinity levels.
2. To promote consistency, the SAS concepts and criteria used in this plan should be incorporated into the District's CUP Program and other components of the District's overall water supply management responsibilities through rulemaking, such as Minimum Flows and Levels (MFLs), coastal saltwater intrusion prevention, wetland protection, aquifer protection from excessive drawdowns, aquifer monitoring, and protection from contamination.
3. As soon as it is feasible, but no later than the five-year update to this plan, the District shall conduct a regional evaluation using the finer grid models currently under development for renewal of CUPs of the effects the projected demands might have on these aquifers and the associated water resources. If this regional analysis identifies potential problems, the District

should revise this plan, and identify specific water resource and water supply development projects to meet the projected needs.

The following water supply development recommendations were made regarding the SAS:

1. The potential of using the SAS for new and expanded uses should be evaluated on a project-by-project basis.
2. Water users and utilities should consider development of alternative water sources that reduce reliance on the SAS.

Intermediate Aquifer System

Definition and Discussion

The Intermediate Aquifer System (IAS) consists of five zones of alternating producing and confining units, with the producing zones being the mid-Hawthorn and Sandstone aquifers.

Sandstone. Similar to the mid-Hawthorn, the Sandstone aquifer has variable thickness. The aquifer thins and eventually pinches out to the south around Alligator Alley, to the northwest in portions of Cape Coral, and to the east in the middle of Hendry County. The aquifer is thickest near Immokalee and portions of Central Lee County. The Sandstone aquifer is recharged through vertical leakance and allocation of this source has been limited by productivity of the aquifer and potential impacts to existing legal users.

Productivity of the Sandstone aquifer is highly variable where present across the LWC Planning Area. The aquifer is the sole source for Lehigh Utilities and is also used by Lee County Corkscrew and Green Meadows wellfields in addition to other sources. In portions of western Hendry County where the lower Tamiami aquifer is absent, the Sandstone aquifer is a primary source of water for agricultural irrigation; however, the limited productivity of this aquifer can not support large-scale agricultural operations in most areas. In Hendry and Lee counties, the Sandstone aquifer is suitable for irrigation purposes throughout its extent with the exception of the LaBelle area, where the aquifer has become contaminated by artesian Floridan wells.

In addition to the physical characteristics of the aquifer, withdrawals from the Sandstone aquifer have been limited by existing legal users, particularly domestic wells and other use type facilities equipped with centrifugal pumps (vacuum type pumps) and short wells. Centrifugal pumps are located on the land surface at the wellhead and withdraw water until water levels in the well fall 20 feet or greater below land surface. Submersible pumps, on the other hand, are located inside the well and can operate at great depths by pumping water up from the bottom of the well. Most large capacity wells are constructed wells with submersible pumps that can withdraw water from greater depths. During low rainfall periods, water use in these wells can cause water levels in the aquifer to drop greater than 20 feet below land surface, causing wells with centrifugal pumps to lose service. Hendry County is the only government that has adopted an ordinance requiring installation of submersible pumps on new construction, but it is not retroactive. Replacement of these inefficient systems as they fail with submersible pumps and appropriately sized well was recognized as the most economic solution.

Mid-Hawthorn. The mid-Hawthorn aquifer is present throughout the LWC Planning Area; however, the aquifer is not always productive due to thickness variability and the presence of interbedded low permeability layers. In addition, the water quality of the aquifer decreases as it dips to the south and east, and produces only saline water in the majority of the LWC Planning Area.

In the past, the mid-Hawthorn provided water for the city of Cape Coral and the Greater Pine Island water utility; however, the limited water producing characteristics of the aquifer and water quality concerns made it an unreliable and insufficient source. The aquifer has limited use for domestic self-supply in areas of Cape Coral that are not served by city water and for small water utilities north of the Caloosahatchee River. Currently, the greatest use of the mid-Hawthorn is for domestic irrigation in Cape Coral and the area southwest of Fort Myers. Elsewhere across the LWC Planning Area, the aquifer is used sporadically for agricultural irrigation.

Intermediate Aquifer System Estimated Costs

The costs related to wellfield expansion for the IAS are provided in **Table 13**. There are additional costs for water treatment. Several of the water treatment facilities in the LWC Planning Area use lime softening for IAS water. Lime softening's cost advantages are in operating and maintenance expenses (**Table 11**), where costs are typically 10 to 20 percent less than for comparable membrane technologies. However, enhanced lime softening and membrane softening are being used by utilities to enhance or replace traditional lime softening due more stringent water quality standards. The cost of membrane softening is indicated in **Table 12**. One significant advantage over lime softening is membrane softening's effectiveness at removing organics that function as a precursor to the formation of disinfection by-products, such as trihalomethanes.

Table 13. Intermediate Aquifer System Well Costs[a].

Intermediate Aquifer System	Drilling Cost (per well)	Equipment Cost (per well)	Engineering Cost (per well)	Operations and Maintenance Cost (per 1,000 gallons)	Energy Cost (per 1,000 gallons)
Costs	$44,000	$62,000	$16,000	$.004	$.030

a. Costs based on a 16-inch diameter well and a maximum well depth of 300 feet.
Source: PBS&J, 1991, Water Supply Cost Estimates, converted to 1999 dollars.

Quantity of Water Potentially Available from Intermediate Aquifer System

Based on the 1994 LWC Water Supply Plan analysis and information contained in Chapter 4, from a regional perspective, increases in production from the IAS beyond existing demands may be limited in some areas due to potential impacts on existing legal users and the productivity of the aquifer. Overall though, it was concluded that the IAS is sufficient to meet existing and proposed IAS projected urban and agricultural demands through 2020. In some areas, this may require modifications to wellfield configurations and pumping regimes with respect to locations of other existing legal users and demands. The volume of water that could be withdrawn by any specific user must be determined through the District's CUP Program.

Intermediate Aquifer System Recommendations

The following water resource development recommendations were made regarding the IAS:

1. The District should review existing water quality and water level monitoring for the IAS aquifers in the LWC Planning Area. Well locations and parameters should be compared with areas of current and projected land use development, utilization of the aquifer, areas of existing saltwater intrusion, and areas where there is a potential for saltwater intrusion. The District's monitoring program will be maintained and should be expanded where appropriate. Emphasis should be placed on monitoring and analysis of water levels and salinity levels.
2. To promote consistency, the IAS concepts and criteria used in this plan should be incorporated into the District's CUP Program and other components of the District's overall water supply management responsibilities through rulemaking, such as MFLs, coastal saltwater intrusion prevention, aquifer protection from excessive drawdowns, aquifer monitoring, and protection from contamination.
3. As soon as feasible, but no later than the five-year update to this plan, the District shall conduct a regional evaluation using the finer grid models currently under development for renewal of CUPs, of the effects the projected demands might have on these aquifers and the associated water resources. If this regional analysis identifies potential problems, the District should revise this plan, and identify specific water resource and water supply development projects to meet the projected needs.

The following water supply development recommendations were made regarding the IAS:

1. The potential of using the IAS for new and expanded uses should be evaluated on a project-by-project basis.
2. Local governments should consider passage of an ordinance requiring installation of positive displacement submersible pumps and appropriately sized wells, especially in Charlotte, Collier, Glades, and Lee counties and in areas where water levels are projected to fall 20 feet or greater below land surface.

Floridan Aquifer System

Definition and Discussion

The Floridan Aquifer System (FAS) underlies all of Florida and portions of southern Georgia and Alabama. It is the principal source of water in Central Florida. However, the FAS yields only nonpotable water throughout most of the LWC Planning Area. The quality of water in the FAS deteriorates southward, increasing in hardness and salinity. With depth, the salinity increases, making the deeper producing zones less suitable for the water supply development than the shallower zones near the top of the aquifer. Within the LWC Planning Area, the FAS is not influenced by variations in rainfall.

Water from the shallow zones must be treated by desalination to produce a potable product. The most productive zones in the FAS are the lower Hawthorn, Suwannee, and Avon Park aquifers. Several utilities in the LWC Planning Area are currently utilizing the FAS to meet their needs including Collier County, the city of Cape Coral, Greater Pine Island, Marco Island Utilities, and the Island Water Association (Sanibel). In addition, the city of Fort Myers is in the permitting phase of development of a FAS wellfield. Elsewhere in the LWC Planning Area, these aquifers supply only a few agricultural irrigation wells. With continued growth and development in the LWC Planning Area, these aquifers will become an important source of water to meet the demand. Although desalination of the water will be necessary for potable use, blending of the raw water with higher quality water could produce a product suitable for irrigation purposes.

In the deeper zone of the FAS, areas of extremely high transmissivity exist, termed boulder zones. These zones are not used for supply sources within the LWC Planning Area due to high salinity and mineral content of the water. However, treated wastewater effluent and concentrate or residual brines from the desalination process are injected into this zone as a means of disposal. Marco Island Utilities, Collier County, Lee County, and North Fort Myers currently use deep well injection for disposal. Several other utilities are planning to use deep well injection including Immokalee and Sanibel.

In addition, zones within the upper portion of the FAS are also used for ASR. Utilities for Marco Island, Collier County and Lee County are currently using ASR.

Within the LWC Planning Area, there is limited information, data, and experience regarding the use of the FAS. Many utilities are using, or planning to use, the FAS to meet existing and future demands. There is a concern for water quality and the long-term sustainability of the FAS. However, based on existing information and experience with the FAS, significant changes in water quality are not anticipated. Consideration of development of a comprehensive FAS ground water model developed for Collier and Lee counties to be used for predictive analysis in the future by the District is recommended. Several local FAS models have been used by Cape Coral, Lee County, and others.

Currently, utilities are drilling into the FAS in the LWC Planning Area for water supply and wastewater disposal. The District should work in conjunction with water users/ utilities to gain water quality and hydraulic information during the scope of work development related to FAS well drilling programs. Information could be gained via packer tests, coring/testing of specific intervals plus geophysical logging (e.g. permeability logs) and aquifer performance testing. In most cases, these activities would be nominal compared to the actual well drilling cost. The District should consider budgeting for these items and cost-share for additional testing and data acquisition. It is also recommended that a FAS monitoring network be established to collect the data necessary to establish the relationship between water use, water levels, and water quality.

Floridan Aquifer System Estimated Costs

The costs related to wellfield development of the FAS are provided in **Table 14.** For potable water use, there are additional costs for desalination treatment, such as reverse osmosis (**Table 15**) and concentrate disposal (**Table 16**). Site-specific costs associated with reverse osmosis (RO) can vary significantly as a result of source water quality, concentrate disposal requirements, land costs, and use of existing water treatment plant infrastructure. As a general rule, RO costs are 10 to 50 percent higher than lime softening depending on the water quality of the source water. For brackish water with total dissolved solids up to 10,000 mg/L, electrodialysis and electrodialysis reversal are generally effective, but cost about five to 10 percent higher than RO treatment (Boyle Engineering, 1989).

Recent improvements in low pressure membranes has reduced the electrical costs associated with RO systems. Because RO pump power consumption is directly proportional to pressure, the low pressure systems can provide significant reductions in power consumption. The RO treatment cost presented herein do not reflect the recent improvements in membrane technology.

Quantity of Water Potentially Available from the Floridan Aquifer

The FAS has been used for many years by several of the coastal utilities in the LWC Planning Area. Several other utilities have recently initiated use of or plan to use the FAS. However, there is limited information, data, and experience on a regional scale regarding the use of the FAS in the LWC Planning Area. This plan did not incorporate the use of a FAS ground water model. A single regional FAS ground water model for the Lee and Collier area does not exist. Several local FAS models have been used by Cape Coral,

Table 14. Floridan Aquifer System Well Costs[a].

Floridan Aquifer System	Drilling Cost (per well)	Equipment Cost (per well)	Engineering Cost (per well)	Operations and Maintenance Cost (per 1,000 gallons)	Energy Cost (per 1,000 gallons)
Costs	$115,000	$65,000	$18,000	$.004	$.040

a. Costs based on a 16-inch diameter well and a maximum Floridan well depth of 900 feet.
Source: PBS&J, 1991, Water Supply Cost Estimates, converted to 1999 dollars.

Table 15. Reverse Osmosis Treatment Costs[a].

Facility Size	Capital Cost (per gallon/ day capacity)	Engineering Cost (per gallon/ day capacity)	Land Requirements (Acres)	Operations and Maintenance Cost (per 1,000 gallons)	Energy Cost (per 1,000 gallons)
3	$1.76	$.26	.40	$.58	$.29
5	$1.59	$.24	.40	$.54	$.29
10	$1.47	$.23	.50	$.51	$.29
15	$1.43	$.21	.63	$.50	$.29
20	$1.46	$.20	.78	$.38	$.29

a. Costs based on 2,000 mg/L TDS, 400 PSI.
Source: PBS&J, 1991, Water Supply Cost Estimates, converted to 1999 dollars.

Table 16. Concentrate Disposal Costs.

Deep Well Disposal Facility (MGD)	Capital Cost (per gallon/day capacity)	Engineering Cost (per gallon/day capacity)	Land Requirements (Acres)	Operations and Maintenance Cost (per 1,000 gallons)
3	$.73	$.109	0.5	$.040
5	$.55	$.083	0.5	$.030
10	$.50	$.075	1.0	$.028
15	$.46	$.070	2.0	$.025
20	$.38	$.056	3.0	$.020

Source: PBS&J, 1991, Water Supply Cost Estimates, converted to 1999 dollars.

Lee County and others. Additionally, this assessment did not incorporate a water quality component. Based on the existing data, knowledge, and experience in the LWC Planning Area, as well as FAS experience in other areas, it was concluded that the FAS could support all of the existing and 2020 projected demands, 56,615 MGY or 155 MGD, of the potable water utilities.

Floridan Aquifer System Recommendations

The following water resource development recommendations were made regarding the FAS:

1. The District should develop a comprehensive FAS ground water model based on all existing and future information available focusing on Lee, Collier, and possibly Hendry counties to conduct predictive analysis in the future. This model would be for use by the District and the public to evaluate both water withdrawals and storage via ASR. The model should be developed and refined with user participation and information collected through the CUP Program, water users, utilities, and other sources with regard to water quality, water levels, and hydrologic characteristics, when appropriate. Other sources that may be utilized include existing monitoring wells or wells that may be converted to monitoring wells instead of being abandoned. Appropriate well site selection should consider model boundary conditions and not be limited to the LWC Planning Area.
2. The District should expand the FAS ground water monitoring network to collect the data necessary to establish the relationship between water use, water levels, and water quality in the LWC Planning Area.
3. The District should develop and recognize partnership agreements during development of the scope of work with water users and utilities, who are or planning to develop the FAS for water supply, ASR, or wastewater effluent disposal. These partnerships will collect water quality, water level, and hydrologic information related to FAS. Information could be gained via packer tests, coring/testing of specific intervals plus geophysical logging (e.g. permeability logs), and aquifer performance testing. The District should budget for these items and cost-share for additional testing and data acquisition. The development of partnerships to share collected data will be in addition to and complementary to other data collection efforts.
4. The District should continue to work with other government entities, including the legislature, the FDEP, and the U.S. Environmental Protection Agency (USEPA) to explore

environmentally acceptable alternative desalination concentrate disposal options.

The following water supply development recommendations were made regarding the FAS:

1. Local water users should consider using the FAS to reduce demands on freshwater sources in the LWC Planning Area. Within the LWC Planning Area, the FAS is not influenced by variations in rainfall.
2. Local water users utilities should consider involving the District in development of their FAS well drilling programs for water supply, ASR, and wastewater effluent disposal to collect FAS water quality, water levels, and hydraulic information that could be used in predictive analysis and development or refinement of a FAS model.

Reclaimed Water

Definition and Discussion

Reclaimed water is water that has received at least secondary treatment and basic disinfection and is reused for a beneficial purpose after flowing out of a domestic wastewater treatment facility. Reuse is the deliberate application of reclaimed water, in compliance with FDEP and District rules, for a beneficial purpose. Potential uses of reclaimed water include landscape and agricultural irrigation, ground water recharge, industrial uses, and environmental enhancement. In 1997, the 22 LWC regional wastewater facilities treated an average of 58 MGD of wastewater, of which 37 MGD was reused. Reuse included irrigation of golf courses, residential lots, medians, and other green space, and ground water recharge via percolation ponds. Utility specific reuse applications can be found in the Support Document and Appendices of this plan.

Reclaimed water has played a significant role in meeting the needs of this region and this is expected to continue. The ground water modeling associated with the 1994 LWC Water Supply Plan found the existing and projected use of reclaimed water in the coastal portions of the LWC Planning Area to reduce demands on the SAS and IAS was very effective at reducing potential exceedances of the wetland protection and seawater intrusion criteria. The volume of reclaimed water that is reused is projected to increase as wastewater flows increase due to development, and as current/proposed reuse programs are implemented. This assessment did not anticipate additional industrial uses of reclaimed water beyond current use, especially for power plant cooling. In addition to supporting continuation of implementation of the utility plans, several options to increase the effectiveness and efficiency of these programs, especially during low rainfall periods, were discussed, including a regional irrigation water distribution system.

In addition to using reclaimed water for irrigation, the potential of using reclaimed water as a saltwater intrusion barrier was discussed. For the SAS, this use could possibly be accomplished by applying reclaimed water at land surface through percolation ponds or trenches along the coast, thereby creating a freshwater mound that would impede the movement of saltwater inland. Or, a series of injection wells could be constructed along the coast to accomplish the same result. However, compliance with federal and state underground injection requirements would have to be negotiated.

Reclaimed Water Estimated Costs

The costs associated with implementation of a reclaimed water program can vary significantly depending on the type of reuse system (i.e., ground water recharge, public access irrigation), the capacity of the reclamation facility, treatment components, the extent of the reclaimed water distribution system, and the regulatory requirements. Cost savings include negating the need for or reducing the use of alternative disposal systems, reducing the demand on ground water systems, and reducing the volume of potable water used for irrigation.

For a reuse system that utilizes reclaimed water for public access irrigation, utility representatives indicated infrastructure cost would be approximately $1.00 per 1,000 gallons, while the operation and maintenance of the system would be around $0.21 per 1,000 gallons. For public access irrigation systems using reclaimed water, the infrastructure cost would include the costs associated with construction of advanced secondary treatment components including filtration, high level disinfection facilities, online continuous water quality monitoring equipment, storage facilities, pumps, and transmission and distribution piping. Operation and maintenance costs would include chemical costs, pumping costs, and maintenance costs for the treatment and distribution system.

Quantity of Water Potentially Available from Reclaimed Water

Wastewater flows to the regional wastewater facilities in the LWC Planning Area and the potential volume of reclaimed water that could be made available is projected to increase to 97 MGD through the planning horizon, an increase of 40 MGD from 1997 flows.

The potential need in the future of applying conservation concepts to reclaimed water systems was discussed. It was suggested reuse systems should be designed to apply reclaimed water sufficiently to meet the needs of the plants, not as a disposal system.

Reclaimed Water Recommendations

There were no individual water resource development recommendations made regarding reclaimed water. Reclaimed water is one of the sources that is contained in the Regional Irrigation System section.

The following water supply development recommendations were made regarding reclaimed water:

1. Local governments should consider adopting building codes and land development regulations requiring proposed new projects exceeding a certain acreage threshold to construct infrastructure and use water from a reclaimed or irrigation water source.
2. Utilities should incorporate water supply considerations in development of their reclaimed water programs. These should include the resource efficiency concept of utilizing reclaimed water for the recharge of wellfields to minimize impacts to the resources.
3. Utilities should consider supplemental sources and interconnection with other utilities to maximize the volume of reclaimed water that is reused. ASR, among other options, should be explored to extend the use of current resources in order to meet future demands, including addressing peaks in demands or in availability of resources.

Regional Irrigation System

Definition and Discussion

To satisfy future demands for irrigation water, the concept of construction and operation of a regional irrigation distribution system as a water resource development project consistent with the provisions in Chapter 373, F.S., was discussed. The system would make irrigation water available for local supply entities/utilities to withdraw from for distribution. Several different configurations were discussed including one large regional system, several subregional systems, or on a utility by utility basis.

One concept involves interconnecting reclaimed water transmission/distribution systems of the regional wastewater treatment facilities. Using this system, reclaimed water would be transferred from areas of surplus to areas where there is not sufficient reclaimed water (and other sources) to meet demands. However, it is estimated that reclaimed water would not be sufficient to meet the demands at all times and would have to be supplemented with water from other sources, such as surface water. Storage could play a critical role in this system to store water (i.e. surface water, reclaimed water) during periods of surplus for use during periods of deficit. The development of this infrastructure may actually be built in components such that there are distinct separate systems. This development may occur as supplemental water sources and storage options are identified and may support different portions of a regional irrigation distribution system without interconnections. As a result, several subregional systems may be optimal.

There are many considerations that should be addressed in evaluating the feasibility of a regional irrigation distribution system further, including the following: the benefits; service area and quantification of demands; institutional framework needed to establish; construction and operation of the system; funding; regulations; and water quality. Preliminary discussions resulted in the following:

Benefits. Some of the potential benefits identified were environmental protection, reduced demands on ground water systems, improved flood protection, water supply, and reduction in PWS demands, and reduced volume of wastewater effluent discharged to the Caloosahatchee River and other surface waters, and/or deep wells. Another benefit is decreasing excess freshwater discharges to estuaries by storing surface water runoff for supplemental supplies for irrigation.

Service Area and Demand Quantification. First, the service area of the system should be identified. It was recommended the service area consist of the urban areas of Lee and Collier counties. Within this area, there would be potential demands for irrigation associated with golf course development, landscaping, and other irrigation needs. In addition to the average demands associated with these uses, the seasonality of demands and supplies need to be addressed, and the lag time between irrigation demands of new developments and generation of wastewater flows should be considered.

Storage. Storage would be a critical part of the system to balance supply and demand, especially for supplemental sources such as surface water. Reservoirs and ASR were identified as potential storage options.

Supplemental Sources. Reclaimed water sources would not be sufficient to meet the projected demands. Several potential sources of supplemental water were identified including the Caloosahatchee River, the Cape Coral Canal System, Golden Gate Canal System, or from created surface water storage features in northern Lee County or in southern Charlotte County. One potential option for an ASR project is to use the Fort Myers Caloosahatchee River PWS withdrawal facilities and wellfield. This project could supplement an irrigation system. Fort Myers is in the process of permitting a Floridan aquifer wellfield to replace this surface water source.

Institutional Framework. Some type of framework to oversee design, construction, development, funding, and operation would have to be identified. The institution could vary from being a series of cooperative agreements between utilities to a taxing district. Cooperation and understanding of roles and responsibilities, including funding and regulation, will need to be agreed upon by participating entities. Utility representatives stated this understanding could be accomplished through interlocal agreements, thereby eliminating an additional layer of government.

Funding. Funding sources would have to be identified to construct an irrigation system. Several potential funding sources were identified including the District's Water Resource Development Funding Program, the District's Alternative Water Supply Grant Program, private funding, and contributions from developers, utilities, local governments, and the state. Projects that involve multiple beneficiaries and have regional benefits could qualify for funding from the District's Water Resource Development Funding Program.

Regulations. Local, regional, and state regulations that could influence an irrigation system were discussed. From the local perspective, local land use ordinances that require construction of dual water distribution systems and use of this system and rates could facilitate this system. To maximize the use and effectiveness of this system, local governments will play a significant role through requiring its use through adoption of building codes and land development ordinances, and through the regulation of rates to ensure its affordability. Regionally, the District issues CUPs that would be required of supplemental sources. At the state level, FDEP has jurisdiction concerning the quality of the water, including treatment and use.

Incentives. Incentives should be established by the District to encourage use of this system, such as longer duration permits and financial participation.

The irrigation system could involve many different aspects and features as indicated in the following example. Cape Coral and their Water Independence for Cape Coral (WICC) Program is projected to have 28 MGD of irrigation demand by 2020. Currently, this system uses a combination of reclaimed water and surface water from the network of secondary canals in Cape Coral to meet these needs. To enhance the supply sources of this program, surplus reclaimed water from Fort Myers could be transferred through the regional irrigation water system to Cape Coral. In addition, the storage in Cape Coral's surface water canal system could be increased through reservoirs and ASR. Surface water currently being discharged to tide through Matlacha Pass could be held in the system through reservoirs and other water retention methods, and potentially be used for environmental enhancement on recently purchased public lands and to augment supplies in the WICC system.

Regional Irrigation System Estimated Costs

The costs associated with construction of a regional irrigation distribution system would vary depending on the extent of the system, location of water sources, location of demands, and the location and size of distribution systems. The system could potentially be one large regional system or a series of subregional or utility systems. Under one extreme, the system could potentially consist of one large pipeline from northern Lee County to southern Collier County that would convey water for irrigation use from a variety of sources, including reclaimed water, surface water, and ground water. The system would make this water available to local distribution entities for ultimate distribution and use. ASR could play a significant role for seasonal storage and peaking in this system.

Another version could be a series of subregional systems where local distribution entities and, in most cases, wastewater utilities, interconnect their reclaimed water distribution systems. Reclaimed water would be supplemented with other sources of water, such as surface water or ground water. Seasonal storage, such as ASR, could also play a significant role in this system as well.

To move forward with this concept, it is recommended that a more detailed study beyond this regional plan be conducted to determine the most effective system to meet the urban irrigation demands. The study should incorporate the following considerations and include participation from representatives of the utilities and users in the LWC Planning Area:

- Benefits
- Service area/demand quantification
- Storage
- Supplemental sources
- Institutional framework
- Funding
- Regulations
- Incentives

Quantity of Water Potentially Available from the Regional Irrigation System

The regional irrigation distribution system would utilize the other sources identified and quantified in this plan, including reclaimed water, ground water, and surface water. The recommended study will identify the most effective way to distribute these sources to maximize their use and satisfy the demands. Storage, primarily through ASR, is envisioned to be a key component of the ultimate system. The regional irrigation distribution system will provide a source of irrigation water in urban areas where historically used sources of ground water, primarily the SAS, will not be sufficient to meet the projected demands.

Regional Irrigation System Recommendations

The following water resource development recommendation was made regarding the regional irrigation system option:

1. The District will evaluate, with assistance from LWC local governments, water users, and utilities, the feasibility of constructing subregional irrigation water distribution system(s) and other options to meet the growing urban irrigation demands of this area. Reclaimed water should be used and where available should be incorporated into the evaluation. The results of this study should be incorporated in the update of this plan.

The following water supply development recommendations were made regarding the regional irrigation system option:

1. Local governments should consider adopting building codes and land development regulations requiring new projects, exceeding a certain acreage threshold, to construct infrastructure and use water from a reclaimed or irrigation water source.
2. Utilities should consider supplemental sources and interconnection with other utilities to maximize the volume of reclaimed water that is reused.

Seawater

Definition and Discussion

This option involves using seawater from the Gulf of Mexico as a raw water source. The Gulf of Mexico appears to be an unlimited source of water from a quantity perspective; however, removal of the salts is required before use for potable or irrigation uses. A desalination treatment technology would have to be used, such as distillation, reverse osmosis, or electrodialysis reversal (EDR).

Seawater Estimated Costs

The cost of desalination of seawater can be significant, several times the cost of reverse osmosis of the FAS. In addition, reverse osmosis and EDR facilities treating seawater would be expected to have an efficiency of 25 percent, resulting in increased concentrate/reject water disposal needs compared to desalination of the FAS.

Tampa Bay Water recently received proposals to construct a seawater desalination treatment facility initially capable of producing 25 MGD of drinking water. All four proposals first-year cost estimates for a thousand gallons of desalinated water were below $2.30 per thousand gallons (with one proposal's first year costs as low as $1.71 per thousand gallons), significantly lower than originally assumed and significantly below the costs for water at similar plants under construction elsewhere. For example, in Singapore, a 36 MGD desalination plant is estimated to cost between $7.52 and $8.77 per thousand gallons.

The Tampa Bay Water proposals total capitalization cost of the regional desalination plant ranged from $98 to $129 million for the facility (Tampa Bay Water, 1999). Some of the factors reducing the cost of this facility include colocating the water treatment plant with a power plant, using the power plant's existing cooling water discharge system for concentrate disposal, and using the power plant's existing facilities for the intake to the water treatment plant.

Quantity of Water Potentially Available from Seawater

The volume of water available from the Gulf of Mexico appears to be unlimited and could meet the needs of this region through 2020.

Seawater Recommendations

It was concluded that seawater is a potential source of water, but at this time, it is not cost-effective.

Storage

Three types of potential storage options were identified: ASR, regional retention, and reservoirs.

Aquifer Storage and Recovery

Definition and Discussion

Aquifer storage and recovery (ASR) is the underground storage of injected water into an acceptable aquifer (typically the FAS in southwest Florida) during times when water is available, and the subsequent recovery of this water during high demand periods. In other words, the aquifer acts as an underground reservoir for the injected water, reducing water loss to evaporation. Current regulations require injected water to meet drinking water standards when the receiving aquifer is classified as an Underground Source of Drinking Water (USDW) aquifer, unless an aquifer exemption is obtained from the USEPA. Obtaining an aquifer exemption is a rigorous process and few have been approved. However, the USEPA has indicated that a flexible assessment approach will be applied for systems that meet all drinking water standards except fecal coliform.

Treated Water ASR. Treated water ASR involves using potable water as the injection water. Since potable water meets the drinking water standards, this type of ASR application is more easily permitted. There are many examples in Florida, including several in the LWC Planning Area, of utilities using treated water ASR. These include Collier County and Lee County utilities.

Raw Water ASR. The use of this technology in the LWC Planning Area was discussed in combination with surface water storage. For northern Lee County, this process involves injection of surface water that has been captured and stored in a reservoir, secondary canal system, or the C-43 Canal to supplement storage and enhance irrigation water supply. The reservoir or canal system would capture excess surface water and provide sufficient volumes of water for the ASR injection cycle. Water levels in the reservoir and canals would then be supplemented with water from the ASR system during drier periods or higher demand periods; or the water could possibly be pumped directly into the irrigation distribution following appropriate treatment. Currently, there are no operating untreated surface water ASR projects in Florida.

Reclaimed Water ASR. Reclaimed water ASR would involve using reclaimed water as the injection water. Several communities in Florida are interested in reclaimed water ASR and are investigating the feasibility of such a system.

Aquifer Storage and Recovery Estimated Costs

Estimated costs for an ASR system largely depend on whether the system requires pumping equipment (**Table 17**). In the table, one system uses pressurized water from a utility. The second ASR system uses unpressurized treated water, thus requiring pumping equipment as part of the system cost (refer to the Support Document for cost assumptions). The latter system with its associated pumping costs is more indicative of an ASR system in combination with surface water storage. There may also be additional costs for screening and filtering untreated surface water to remove floating and suspended matter.

Table 17. Aquifer Storage and Recovery System Costs[a].

System	Well Drilling Cost (Per Well)	Equipment Cost (Per Well)	Engineering Cost (Per Well)	Operations and Maintenance Cost (per 1,000 gallons)	Energy Cost (per 1,000 gallons)
Treated Water at System Pressure	$250,000	$40,000	$450,000	$.005	$.08
Treated Water Requiring Pumping	$250,000	$125,000	$500,000	$.008	$.08

a. Costs based on a 900-foot, 16-inch well, with two monitoring wells using treated water.
Source: PBS&J, 1991, Water Supply Cost Estimates, converted to 1999 dollars.

Quantity of Water Potentially Available from Aquifer Storage and Recovery

The volume of water that could be made available through ASR wells depends upon several local factors, such as well yield, water availability, variability in water supply, and variability in demand. Without additional information, it is not possible to accurately estimate the water that could be available through ASR in the LWC Region. Typical storage volumes for individual wells range from 10 to 500 million gallons or 31 to 1,535 acre-feet (Pyne, 1995). Where appropriate, multiple ASR wells could be operated as a wellfield, with the capacity determined from the recharge and/or recovery periods. There are potentially many different applications of ASR; however, all store sufficient volumes (adequate volumes to meet the desired need) during times when water is available and recover it from the same well(s) when needed. The storage time is usually seasonal, but can also be diurnal, long-term, or for emergencies. The volume of water that could be made available by any specific user must be determined through the District's CUP Program.

Aquifer Storage and Recovery Recommendations

The following water resource development recommendations were made regarding ASR:

1. The District should continue working with other governmental entities including the legislature, congress, USEPA, and FDEP to explore rule changes to the federal and state Underground

Injection Control (UIC) program to allow for (and encourage) injection of untreated or partially treated ground water or surface water with ASR. The level of treatment should be compatible with the water quality in the proposed storage zone.

2. The District should develop CUP rules to address the use of the Floridan aquifer for ASR, as well as water use, and to assure compatibility between use concepts.

The following water supply development recommendation was made regarding ASR:

1. Utilities should explore ASR, among other options, to extend the use of current resources in order to meet future demands, including addressing peaks in demands or in availability of resources.

Regional and Local Retention

Definition and Discussion

Regional and local retention looks at opportunities to increase water storage in watersheds through the manipulation and modification of the drainage system that serves that area, while still maintaining an appropriate level of flood protection. Much of the LWC Planning Area was drained to support agricultural and urban development. This has resulted in lowered ground water tables that may impact natural systems, as well as water availability in these areas. The analysis in the 1994 LWC Water Supply Plan concluded that modifying water levels in existing drainage canals and eliminating unnecessary canals can significantly elevate ground water levels in some areas. Committee members stated that the work completed by the Big Cypress Basin that increased water retention in their canal system to increase ground water levels, has resulted in reducing the frequency of irrigation. Several regional and local retention projects are being proposed and implemented including the Big Cypress Basin Watershed Management Plan, East Lee County Aquifer Recharge Project, and the city of Cape Coral’s Gator Slough/Reuse System Enhancement Program.

Big Cypress Basin Watershed Management Plan. The Big Cypress Basin has developed the Big Cypress Basin Watershed Management Plan (BCBWMP). The BCBWMP considers a range of alternative water management strategies to augment water supply and restore historic flowways by interbasin transfer through modifications of its primary canal network. Some of the water supply enhancement alternatives being recommended in the BCBWMP are as follows:

- Diversion of a portion of Golden Gate Main Canal flows to the Henderson Creek Basin
- Assess implementability of ASR to store Golden Gate Canal wet season flows near County Road (CR) 951

- Diversion of a portion of Corkscrew Canal system flows eastward to Golden Gate Canal north of Weir No. 5
- Retrofit Faka Union Canal Weirs No. 4 and 5 to augment recharge potential for the city of Naples East Golden Gate Wellfield
- Modify C-1 Connector and relocate Miller Canal Weir No. 3 to enhance recharge of the Collier County South Wellfield
- Restore historical flowways of the Camp Keais Strand
- Implement Cocohatchee flowway in coordination with (Corkscrew Regional Ecosystem Watershed (CREW) trust and all proposed developments in northern Collier County
- Improve CR 951 Canal to design conveyance and install water control structure to prevent overdrainage
- Explore the integration of South Golden Gate Estates (SGGE) hydrologic restoration plan pumping elements with dry season return flows in the northern reaches of the Miller and Faka Union Canals within the constraints of the SGGE restoration

East County Water Control District. The East County Water Control District (ECWCD) is located in eastern Lee County and western Hendry County, encompassing approximately 70,000 acres. The ECWCD provides drainage for Lehigh Acres and western Hendry County. The ECWCD is currently implementing their East Lee County Aquifer Recharge Project. This project involves modification and replacement of control structures to raise water levels within their district. Phase II-1 covers 9,084 acres of their district. The project involves construction of five new structures, replacement or modification of nine existing structures, and installation of two culverts. The project will reduce runoff by adding about 220 acre-feet of storage in the canals, increase detention, increase recharge to the surficial and Sandstone aquifers, and restore the hydroperiod to 400 acres of wetlands. The cost of the project is $800,000 (ECWCD, 1999).

City of Cape Coral. The city of Cape Coral is also using regional retention to increase water availability in their canal system to supplement the city’s reuse irrigation system. The Gator Slough/Reuse System Enhancement Program has involved improving weir structures, raising heights of some weirs and rehabilitation of others, and vegetative removal from the slough. The project increases the amount of water stored at the end of the wet season in the Cape Coral area, reduces excessive and harmful discharges of fresh water to the Matlacha Pass Estuary, increases drainage efficiency, and reduces flooding problems in the North Fort Myers area. The city is currently in Phase III of the program, which involves installation of a horizontal well and construction of a pump station and pipeline to transfer water from one area to another. It is estimated this project will increase the effective capacity of the reuse system by 19 MGD and have a total cost of $688,500 (City of Cape Coral, 1999).

Restore Historical Flow Patterns. Historically, flows on the mainland of the LWC Planning Area sheetflowed generally towards the south and southwest to what is now the Big Cypress Basin and Ten Thousand Islands. This flow regime has been significantly modified by surface water management features and practices. The possibility of returning, to some extent, the historic drainage direction was discussed. Restoration of historic flow patterns in the Big Cypress Basin Canal network is being addressed in the Big Cypress Basin Watershed Management Plan (see Surface Water Option).

Regional and Local Retention Estimated Costs

The cost of regional and local retention can vary depending on the extent and topography of the watershed being modified, the considerations used in the initial system design and construction, the condition of existing facilities, and the existing operations protocols. The Big Cypress Basin Five-Year Capital Improvement Project costs to implement the recommendations identified earlier in this chapter are identified in **Table 18**.

Table 18. Big Cypress Basin Five-Year Capital Improvement Project Costs.

Year	Project Description	Cost ($)
2000	CR 951 Canal Improvements	2,424,000
	Cocohatchee Phase 4	1,000,000
	Henderson Creek Structure Modification	200,000
	Southern Golden Gate Estates (SGGE)	500,000
	Critical Restoration (Managerial Reserve)	534,833
	Tamiami Trail Flow Enhancement	479,136
2001	Golden Gate No. 1 Retrofit	2,500,000
	Critical Restoration (Managerial Reserve)	800,000
	Land Acquisition - Faka Union No. 5 Retrofit	50,000
	Faka Union No. 5 Retrofit	750,000
2002	Critical Restoration (Managerial Reserve)	1,000,000
	Corkscrew Canal Structures	500,000
	Land Acquisition - Faka Union No. 4	50,000
	Henderson Creek Diversion	1,500,000
2003	Faka Union No. 4 Retrofit	2,000,000
	Land Acquisition - Miller No. 3 Retrofit	50,000
	Critical Restoration (Managerial Reserve)	1,000,000
2004	C1 Connector, Miller No. 3 Modification	2,000,000
	Critical Restoration (Managerial Reserve)	1,000,000

In Cape Coral, the Gator Slough/Reuse System Enhancement Program cost $688,500 and has the potential to increase water availability by 19 MGD. The East Lee County Aquifer Recharge Project Phase II-1 will raise water levels in 9,084 acres and the project cost is $800,000.

Quantity of Water Potentially Available from Regional and Local Retention

Similar to the cost of regional and local retention, the quantity of water that could be made available from regional and local retention is site-specific. The quantity of water that could be made available will vary depending on the extent and topography of the watershed being modified, the initial considerations used in the initial system design and construction, the condition of existing facilities, and the existing operations protocols. The Cape Coral Gator Slough/Reuse System Enhancement Project has the potential to increase water availability by 19 MGD, while the East Lee County Aquifer Recharge Project Phase II-1 will raise water levels in 9,084 acres watershed and provide 220 acre-feet of additional storage in their canal system.

The Big Cypress Basin estimates that implementation of the BCBWMP will increase water storage in their system by at least 60,000 acre-feet or 19,600 MG. This was based on the additional volume of water that will be stored in the canals resulting from increased water levels. Only in SGGE was the increase in the water table (water stored in the aquifer) accounted for. Additional storage will also be created with the other projects. These projects will conserve fresh water through retention of additional fresh water in the watershed and decreasing the volume of excess water discharged to estuarine systems, increase water availability through ground water recharge, and potentially reduce the frequency of irrigation (and demands) by increasing soil moisture through increased ground water levels.

It is anticipated several other regional and local retention projects could occur over the next five years. The projects might include additional work in the Gator Slough and the Fred C. Babcock/Cecile Webb Wildlife Management Area, the southern CREW land, and projects related to implementation of the South Lee County Watershed Plan.

Regional and Local Retention Recommendations

The following water resource development recommendation was made regarding regional and local retention:

1. Regional retention projects that raise water levels through either system modifications or operation changes and benefit water supply without causing environmental harm should be considered for cost-sharing from the District's Water Resource Development funds. Potential retention projects as described above include Big Cypress Basin projects and possibly additional work in the Gator Slough and the Fred C. Babcock/ Cecile M. Webb Wildlife Management Area, the southern

CREW land, and projects related to implementation of the South Lee County Watershed Plan.

The following water supply development recommendation was made regarding regional and local retention:

1. Local and subregional entities that have responsibility for surface water management, such as the 298 Drainage Districts, should evaluate their systems for the potential of increasing storage and raising ground water levels through changes in their operations and/or modifications to control levels.

Reservoir

Definition and Discussion

This option involves the capture and storage of excess surface water during rainy periods and subsequent release during drier periods for environmental and human uses. Regionally, surface water storage could be used to attenuate freshwater flows to the Caloosahatchee Estuary and other estuarine water bodies during rainy periods and to meet minimum flows during drier times. In addition, these facilities could increase surface water availability for current and projected uses, and decrease the demand on aquifer systems. However, evaporative and seepage losses could significantly effect water availability and need to be considered.

Strategically located surface water storage (primarily storage in combination with improved storm water management systems) could recharge SAS wellfields, reduce the potential for saltwater intrusion, and reduce drawdowns under wetlands. On-site storage in agricultural areas may reduce the need for water from the regional canal system and withdrawals from other water source options. Storm water reservoirs could be colocated with ASR facilities and provide a water source for the facility.

Lower East Coast Regional Water Supply Plan, LWC Water Supply Plan, and the CWMP Relationship. Lake Okeechobee is a shared resource between the Lower East Coast (LEC) Regional Water Supply Plan and the LWC Water Supply Plan serving as a limited supply source for the Caloosahatchee Basin. The CWMP supported both of these water supply plans by identifying basin issues, defining the 2020 water demands in the basin, determining the balance of these demands that would have to be met through local storage, and recommendations. The LEC Regional and the LWC water supply plans include the surface water related recommendations from the CWMP. The LWC Water Supply Plan recognizes that implementation of these recommendations will be primarily addressed through the LEC Regional Water Supply Plan and the Southwest Florida Study. Refer to the CWMP and the LEC Regional Water Supply Plan for additional information.

The CWMP and LEC Regional Water Supply Plan incorporated the proposed facilities identified in the Restudy. The facilities were titled as the Caloosahatchee/C-43 Basin Storage Reservoir(s) with ASR, and the design includes 20,000 acres of reservoir(s) at eight-feet maximum depth and ASR wellfields consisting of 22 10-mgd wells. The purpose of these facilities is to capture basin runoff and releases from Lake Okeechobee.

Reservoir Estimated Costs

Costs associated with surface water storage vary depending on site-specific conditions of each reservoir. A site located near an existing waterway will increase the flexibility of design and management and reduce costs associated with water transmission infrastructure. Another factor related to cost would be the existing elevation of the site. Lower site elevations would allow for maximum storage for the facility while reducing costs associated with water transmission and construction excavation. The depth of the reservoir will have a large impact on the costs associated with construction. Deeper reservoirs result in higher levee elevations that can significantly increase construction costs.

Costs associated with two types of reservoirs are depicted in **Table 19**. The costs typically reflect construction for larger regional scale systems and may not be applicable to smaller project scale systems. The first is a minor facility with pumping inflow structures and levees designed to handle a maximum water depth of four feet. It also has internal levees and infrastructure to control internal flows and discharges. The second type is a major facility with similar infrastructure as the minor facility. However, the design depths for this facility range from 10 to 12 feet. Costs increase significantly for construction of higher levees but can be offset somewhat by the reduced land requirements.

Table 19. Reservoir Costs.

Reservoir Type	Construction Cost ($/acre)	Engineering/ Design Cost ($/acre)	Construction Admin. ($/acre)	Land ($/acre)	Operations and Maintenance ($/acre)
Minor Reservoir	2,842	402	318	3,000 – 6,000	118
Major Reservoir	7,980	904	451	3,000 – 6,000	105

Source: SFWMD.

Minor reservoir costs are based on actual construction bid estimates received and awarded for similar projects built in the Everglades Agricultural Area (EAA). Costs of these four Stormwater Treatment Areas (STAs) were averaged to develop the dollar per acre costs. Land costs have been changed to generally reflect land values in the LWC Planning Area ($3,000 for undeveloped/fallow land and $6,000 for land in citrus production). Major reservoir costs were developed based on the average cost estimates from the proposed Ten Mile Creek project in St. Lucie County and from the Regional Attenuation Facility Task Force Final Report, April 30, 1997, estimates for major Water Preserve Areas on the east coast.

Liner Costs. The costs to install a high-density polyethylene liner vary depending on the depth of the area to be lined. For depths of 20 feet or less, the liner will cost approximately $0.20 per square foot installed, whereas it will cost about $0.50 per square foot installed for depths between 20 and 40 feet. Eighteen inches of fill cover will cost about $3.00 per cubic yard and clearing, grubbing, and leveling (does include fill) will cost approximately $1,000 per acre. These cost estimates were based on a combination of manufacturer information, consultant experience, Everglades Construction Project experience, and Means estimating guide.

Quantity of Water Potentially Available from Reservoirs

Reservoirs are considered more of a management option in that these systems allow more efficient use of other sources, such as surface water. Please refer to other source option descriptions for an estimate regarding the quantity of water that potentially could be made available.

Reservoir Recommendations

No water resource development recommendations were made regarding reservoirs. Regional and distributed small scale reservoirs are only being recommended in the Caloosahatchee Basin. Refer to the Surface Water section regarding this recommendation and others from the CWMP recommendations.

The following water supply development recommendation was made regarding reservoirs:

1. Agricultural operations should incorporate water conservation and water supply considerations in design of new or retrofitted surface water management systems.

Surface Water

Definition and Discussion

This option involves the use of surface water as a supply source. Surface water bodies in the LWC Planning Area include lakes, rivers, and canals. Lake Trafford and Lake Hicpochee are the two largest lakes within the LWC Planning Area, but neither is considered a reliable source of water supply. Currently, surface water is a major supply source in the Caloosahatchee Basin for agricultural irrigation and two PWS utilities (Fort Myers and Lee County utilities).

Several potential sources of surface water were identified that could be considered to meet future demands. Most of these potential sources convey water from inland areas and discharge to estuarine systems along the coast. The volume of surface water that could be considered available from these sources for human uses would be the volume that is discharged to the estuary that is considered harmful to the receiving water body and exceeds the needs of the estuary. Water would usually be available during the wet season from these sources, but limited during the dry season.

The LWC Planning Area has been impacted significantly by development of the land to allow for agricultural and urban uses. This development has changed the volume and timing of surface water runoff, which has had a negative impact on the estuarine systems. This runoff condition is being evaluated throughout the LWC Planning Area. It is recommended that as solutions are developed to these conditions the potential to increase surface water availability be considered as, including storage systems, such as ASR and reservoirs, and alternative uses for this excess water. Potential sources of surface water include the Caloosahatchee River (C-43 Canal), the Golden Gate and Faka Union Canal System in Collier County, and several others in Lee County.

Caloosahatchee River

The Caloosahatchee River is the primary source of surface water in the region. The river is supplied by inflows from Lake Okeechobee and rainfall and runoff within its own basin. The freshwater portion of the river (C-43 Canal) extends eastward from the Franklin Lock and Dam (S-79) towards Lake Okeechobee. West of S-79, the river mixes with estuarine water as it empties into the Gulf of Mexico. The C-43 Canal is a significant source for agriculture water supply and to a much lesser extent, for PWS. MFLs criteria are also under development for the Caloosahatchee Estuary. Water availability from the C-43 Canal was addressed in the CWMP.

Caloosahatchee Water Management Plan

The CWMP supported both the LEC Regional and LWC water supply plans by identifying issues within the Caloosahatchee Basin, defining the 2020 water demands in the basin, determining the balance of these demands that could not be met from Lake Okeechobee and that would have to be met through local means, and making recommendations to meet the projected water demands in the basin. The LEC Regional and LWC Water Supply Plans include the surface water related recommendations from the CWMP. The LWC Water Supply Plan recognizes that implementation of these recommendations will be primarily addressed through the LEC Regional Water Supply Plan, the Southwest Florida Study, and the CERP.

The CWMP combines five storage options (regional and distributed reservoirs, ASR, backpumping, a water control structure on the C-43 Canal, and water harvesting) into nine potential alternatives varying from do nothing to do everything. The components are described in Chapter 4 of the CWMP Planning Document and in the CWMP Support Document. The nine alternatives, which were identified for assessment following preliminary screening are as follows:

- Do Nothing (A.01)
- Restudy Alternative (A.02)
- Restudy Without Backpumping (A.03)

- Regional and Distributed Small-scale Reservoirs (A.04)
- Regional Reservoir Only (A.05)
- Water Harvesting (A.06)
- Regional and Distributed Small-Scale Reservoirs with New Structure (S-78.5) (A.07)
- Regional Reservoir with New Structure (S-78.5) (A.08)
- Do Everything (A.09)

Do Nothing (A.01). The Do Nothing Alternative represents the status quo and involves a projection of demands including environmental, agricultural, and urban to 2020 conditions while maintaining the current sources and infrastructure within the Caloosahatchee Basin.

Restudy Alternative (A.02). The Restudy Alternative is based on the recommended Restudy Alternative D13R (USACE and SFWMD, 1999). It is made up of the components described in the D13R for the Caloosahatchee Basin and consists of 160,000 acre-foot reservoir, 44 ASR wells (up to 5 MGD capacity each) and backpumping of excess runoff to Lake Okeechobee following treatment in a STA.

Restudy without Backpumping Alternative (A.03). The Restudy Without Backpumping Alternative is the same as Alternative A.02 (Restudy Alternative) with the backpumping component removed. The Caloosahatchee Advisory Committee suggested this alternative.

Regional and Distributed Small-Scale Reservoirs Alternative (A.04). The Regional and Distributed Small-Scale Reservoirs Alternative models one large regional and distributed smaller reservoirs. The regional reservoir is modeled with the same parameters and assumptions as in Alternative A.02 (Restudy Alternative) with additional distributed reservoirs located in the east and west basins, and on the north and south sides of the river to supply irrigation demands.

Regional Reservoir Alternative (A.05). The Regional Reservoir Alternative considered the option of meeting the storage requirements within the Caloosahatchee Basin from a regional reservoir system. The regional reservoir would be similar to the regional reservoir considered for the Restudy Alternative (A.02), but would be larger in order to provide the storage that is provided by the ASR facility in Alternative A.02.

Water Harvesting Alternative (A.06). The Water Harvesting Alternative investigated the volume of water that would be generated by returning some of the drained area north of the river to predevelopment conditions. Water harvesting was suggested as a viable low cost method of detaining water and reducing the size of the regional reservoir system.

Regional and Distributed Small-Scale Reservoirs with a New Structure Alternative (A.07). The Regional and Distributed Small-Scale Reservoirs with a New Structure Alternative considered a regional reservoir system, smaller distributed reservoirs, and a new structure situated between S-78 and S-79 upstream of LaBelle. As part of this alternative, the existing structure at S-78 would be raised by approximately three feet from 11 feet to 14 feet (NGVD).

Regional Reservoir with a New Structure Alternative (A.08). The Regional Reservoir with a New Structure Alternative considered a regional reservoir system, and a new structure situated between S-78 and S-79 upstream of LaBelle. The structure is as described in Alternative A.07.

Do Everything Alternative (A.09). The Do Everything Alternative, as the name implies, considered all the storage components identified.

The results of this analysis indicated the existing configuration and water deliveries to the C-43 Canal are not sufficient to meet the projected water demands. The results also indicated that water availability with implementation of the CERP recommendations would not be sufficient to meet the 2020 demands. Alternative 9, which represents a combination of the five storage options, provided sufficient storage to meet the projected demands. Development of a preferred alternative will be undertaken as part of the Southwest Florida Study. These recommendations will be primarily addressed through the LEC Regional Water Supply Plan, the Southwest Florida Study, and the CERP. Refer to the CWMP the LEC Regional Water Supply Plan, and the CERP for additional information.

Golden Gate and Faka Union Canal System

The Golden Gate Canal and the Faka Union Canal System in the Big Cypress Basin provide drainage to a 330 square mile watershed, with combined average daily outflows of 560 cfs (362 MGD) and an average wet season flow of 1,020 cfs (660 MGD). In spite of control of flow through a series of water control structures, significant volumes of freshwater are lost to tide. This has resulted in undesirable salinity fluctuations in Naples Bay and Faka Union Bay estuaries. Big Cypress Basin presently operates three back pumping facilities to capture some of the fresh water outflows during the dry season to stimulate regional ground water recharge. The wet season flows of these canals can potentially be utilized for water supply needs if storage, such as ASR, is provided.

Other Potential Surface Water Sources

Several other potential surface water bodies were identified that should be evaluated for future water supply, including the Orange River, Ten Mile Canal, Six Mile Cypress Slough, Imperial River, and Kehl Canal. These were primarily discussed as supplemental sources to reclaimed water systems when water is available and as potential sources to capture and store (mostly through ASR) excess surface water during the wet season for use during the dry season.

An analysis of estuarine and other environmental needs similar to the analysis conducted on the Caloosahatchee River is necessary prior to using these sources for human needs. These systems need to be analyzed for availability of water and in doing so, the rate and no harm type contribution. Establishment of MFLs should be considered where appropriate. The vehicle for this determination could be the Southwest Florida Study. No recommendation is made regarding the specific water availability from these systems at this time. The identified use in this plan for any excess water would be to supplement other water sources to meet projected irrigation demands. The schedules for conducting the regional irrigation distribution feasibility study and the schedule for the Southwest Florida Study are relatively concurrent. There are sufficient quantities of water from other sources that could be used while these determinations are being done.

Several considerations need to be addressed in evaluating surface water availability, including seasonal fluctuations in water availability, environmental needs both upstream and downstream, established MFLs, storage options, and restoration efforts. Several critical restoration projects have been authorized in southwest Florida, including the Southern Corkscrew Regional Ecosystem Watershed (CREW) Project, Addition/Imperial River Flowway, and the Lake Trafford Restoration Project.

Orange River. The Orange River is located northeast of Fort Myers in west-Central Lee County. The Orange River flows northwest and outflows to the Caloosahatchee Estuary and receives inflows from the Able Canal, which provides drainage for Lehigh Acres.

Ten Mile Canal. Ten Mile Canal is located in the Estero Bay Basin in southern Lee County. Its runs north-south through the urbanized areas of south Fort Myers. Ten Mile Canal flows south into Mullock Creek, which discharges into Estero Bay. Ten Mile Creek is not tidally influenced and receives inflows from Six Mile Cypress Slough.

Six Mile Cypress Slough. Six Mile Cypress Slough is publicly owned, is about nine miles long, and encompasses approximately 2,000 acres. It flows southwesterly from southeast of the city of Fort Myers through a water control structure into Ten Mile Canal. Currently, Lee County is in the process of restoring this system.

Imperial River. The Imperial River is located in southern Lee County and flows through the Bonita Springs area. The Imperial River has been the center of several recent flooding events. The development of storage for use as part of an irrigation system could enhance, to some degree, flood protection in this area. The Imperial River receives water from the Kehl Canal.

Kehl Canal. The Kehl Canal lies east of the Imperial River in southern Lee County. The Kehl Canal discharges to the Imperial River. In recent times, this canal has received high flows that resulted in flooding of its banks and the Bonita Springs area. The capturing of high flows for storage may have additional flood protection benefits.

Surface Water Estimated Costs

The existing and potential projected uses for surface water in the LWC Planning Area include agricultural irrigation, potable water supply, and urban irrigation. Potential costs associated with use of this option include the cost of facilities to withdraw water, storage if appropriate, and treatment. Withdrawal costs would include the cost of intake piping and pumping. The costs associated with different storage options are identified in the storage section of this chapter. Treatment cost varies based on the use type. For potable water supply, Lee County is proposing to enhanced membrane softening treatment for water from the C-43 Canal. Membrane softening costs are listed in **Table 12**. For irrigation uses, some filtration would be required to remove suspended matter in the water that could potentially clog irrigation heads.

In addition to the required pumping appurtenances, filtration and disinfection would be required for water that would be used to supplement reclaimed water supplies. A canal pump station in Cape Coral, used to supplement reclaimed water supplies to their residential irrigation system, cost approximately $1.9 million a couple of years ago. This included a 20 MGD capacity pump station with auxiliary power generation equipment, strainer type filtration, disinfection, and a house structure to match the surrounding neighborhood. Recent reuse rule changes may effect some of these components for a similar structure built today.

Quantity of Water Potentially Available from Surface Water

Caloosahatchee River

Inflows to the Caloosahatchee Basin come from three major sources: precipitation, releases from Lake Okeechobee, and ground water seepage. The principle water use/loss mechanisms are evaporation, evapotranspiration (including irrigation), discharge to the estuary for environmental needs, and PWS.

Based on the recommended developments of water management and storage infrastructure to effectively capture and store the surface water flows in the Caloosahatchee Basin, the projected surface water needs of this basin and the estuary can be met. Supplemental agricultural demands from surface water sources within the basin are projected to increase from 230,000 acre-feet per year (200 MGD) based on 1995 land use to approximately 320,000 acre-feet per year (285 MGD) on average based on projected 2020 land use. PWS needs from the Caloosahatchee River are projected to increase from 13,000 (12 MGD) in 1995 to 18,000 acre-feet per year (16 MGD) on average by 2020. The environmental needs of the Caloosahatchee Estuary have been estimated at 450,000 acre-feet (400 MGD) while average flows to the estuary are estimated to be approximately 650,000 acre-feet per year (580 MGD) on average. Flow to the estuary in excess of the needs can, therefore, be as high as 200,000 acre-feet per year (180 MGD) on average. It was concluded that the evaluated components, once constructed, will be adequate to meet the demands during a 1-in-10 year drought condition.

Golden Gate and Faka Union Canal System

The Golden Gate Canal and the Faka Union Canal System in the Big Cypress Basin have combined average daily outflows of 560 cfs (362 MGD) and an average wet season flow of 1,020 cfs (660 MGD). This has resulted in undesirable salinity fluctuations in Naples Bay and Faka Union Bay estuaries. Big Cypress Basin presently operates three backpumping facilities to capture some of the freshwater outflows during the dry season to stimulate regional ground water recharge. There is significant potential for utilizing the wet season flows of these canals for water supply needs if storage is provided, such as ASR. The environmental needs of the estuarine systems and the SGGE Restoration Project will need to be identified to determine the specific volume of water available.

Other Potential Sources

Several other potential surface water bodies were identified that should be evaluated for water availability, including Orange River, Ten Mile Canal, Six Mile Cypress Slough, the Imperial River, and Kehl Canal. An analysis of estuarine and other environmental needs similar to the analysis conducted on the Caloosahatchee River is necessary and recommended in this plan prior to using these sources for human needs. These systems need to be analyzed for availability of water and in doing so, the rate and no harm type contribution, as well as the MFLs for the estuarine system would have to be defined. No recommendation is made at this time regarding the specific water availability from these systems.

Surface Water Recommendations

Water resource development recommendations were made regarding surface water These include the recommendations from the CWMP, as well as those identified during the LWC water supply planning process:

1. Recommendation from the CWMP - Caloosahatchee River ASR Pilot Project: The District should work cooperatively with the USACE to site, design, construct, and operate a pilot regional ASR project. Recovery performance and additional information obtained from the construction of and cycle testing at this facility will guide the design of the regional ASR wellfield.
2. Recommendation from the CWMP - The SFWMD should cooperate with the U.S. Army Corps of Engineers (USACE) in development of the PIR, design, construction, and operation of a regional reservoir and ASR project within the Caloosahatchee Basin. A comprehensive geologic and geotechnical investigation should be completed as a part of the PIR to provide the information needed to size and design the reservoir. Development of the PIR, land acquisition, design, and plans and specifications should be completed by 2005. Construction should be initiated in 2005.

3. Recommendation from the CWMP - The SFWMD should work in cooperation with the USACE to initiate and complete the Southwest Florida Study by 2005 as recommended in the CERP. The modeling work that has been completed as a part of the CWMP should be used as the basis for development of a preferred alternative to meet the demands within the Caloosahatchee Basin in 2020. The primary purpose of the Southwest Florida Study should be to provide a framework in which to address the health of aquatic ecosystems; water flows; water quality (including appropriate pollution reduction targets); water supply; flood protection; wildlife and biological diversity; and natural habitat. Evaluations involving surface water availability for water supply purposes should be based on providing a 1-in-10 level of certainty from surface water as an optimal goal.

4. Recommendation from CWMP - Establish MFLs for the Caloosahatchee River and Estuary by December 2000 in accordance with Section 373.042, F.S. The MFLs will be incorporated into rulemaking.

5. Recommendation from CWMP - The Well Abandonment Program that was administered by the SFWMD (ended in 1991) was a voluntary program that identified abandoned artesian wells, geophysically logged them, and plugged or rehabilitated the wells, as necessary, to prevent deterioration of the SAS through upland leakage or discharge at land surface. The program documentation indicates that there are unplugged wells remaining within the Caloosahatchee Basin that if plugged, could contribute an estimated net flow of 50,000-acre feet per year to the water budget of the Caloosahatchee Basin. In addition, the Florida Geological Survey, Bureau of Oil and Gas, have identified oil test wells within the Caloosahatchee Basin that have not been adequately plugged. Additional effort should be made to locate and properly abandon the free flowing wells in the Caloosahatchee Basin. The SFWMD should work with local and state officials to locate uncontrolled abandoned wells and identify plugging strategies and applicable funding sources for proper plugging of the wells.

6. Recommendation from CWMP - Saline water (in excess of 250 milligrams per liter [mg/L]) has been a recurring problem for the potable water intakes in the Caloosahatchee River (approximately one-mile upstream of S-79). During extended periods of low-flow, the chloride content of the surface water increases well beyond the recommended limit of 250 mg/L for drinking water. The actual number of times that releases have been made from Lake Okeechobee in response to saltwater in

excess of 250 mg/L is relatively few. A number of alternatives to these releases warrant further investigation. Among these are moving the intake farther upstream, modifications to the structure, limiting lockages during low flow periods, and improved maintenance and operation of the bubble curtain. Future freshwater releases for environmental purposes may also minimize saltwater influence. Additional analysis of the saline water problem should be initiated.

7. Recommendation from CWMP - The SFWMD should continue working with the legislature, USEPA, and FDEP to explore rule changes to the federal and state Underground Injection Control program to allow for (and encourage) injection of untreated or partially treated ground water or surface water with ASR. The level of treatment should be compatible with the water quality in the proposed storage zone.
8. Recommendation from LWC Water Supply Plan - The Southwest Florida Study should evaluate estuary and other environmental needs for the flows from surface water bodies including: Orange River/Harn's Marsh/East County Water Control District (Lehigh Canals), Imperial River/Kehl Canal, Ten Mile Canal/Mullock Creek, Golden Gate Canal/Gordon River, and the Faka Union Canal. The results of this evaluation should be incorporated into future LWC Water Supply Plan updates.

The following water supply development recommendation was made regarding surface water:

1. Identify potential sources and amounts of surface water available that could be used to meet projected demands.

Unit Production Costs for Water Source Option Development

Cost information has been provided throughout this chapter that could be used to estimate the planning level total cost for different capacities for each of the water source options. This cost information was presented using the same categories in order to provide comparable cost estimates. The water supply cost estimates allow a relative comparison of the total cost for each alternative considered. To ensure this internal comparability, the following cost estimate categories were used:

- Capital cost (including well drilling cost, construction cost, equipment cost, land cost and engineering cost)
- Operation and maintenance cost (including energy cost)

Total costs, which account for all expenditures, are an estimate of life-cycle costs and are a function of the total capital costs, the expected life of the constructed facilities, the time value of money, and annual operation and maintenance costs. These cost estimates aid in comparing alternatives with differing economic characteristics.

This cost information was used to develop planning level unit production costs for each water source option (**Table 20**). The unit production cost equals the total costs divided by water production, expressed in dollars per 1,000 gallons. For all source options, the time value of money equals 6 5/8 percent per year, consistent with discount rates used by the USACE. A 30-year fixed capital asset life was assumed and an operating level of 70 percent of capacity was used. To arrive at the unit production costs over the 20-year planning horizon, the unused capital value at the end of the 20-year planning horizon (one-third of total capital value based on straight-line depreciation) was deducted from the expenditure based costs. All costs are expressed in constant 1999 dollars.

Because these cost criteria were used in all economic calculations, the relative cost between source options is comparable. However, the unit production costs presented here are not necessarily directly comparable to unit production costs developed in other investigations. To be considered comparable, cost estimates must use the same economic criteria.

For most of the water source options, general assumptions were used to generate the unit cost information. These costs can be highly variable depending on the specific situations of users, as reflected in the cost ranges for some of the options. In addition, the availability of water was not considered. Water supply costs vary for a number of reasons including, but not limited to the following:

1. Hydrogeologic and hydrologic conditions relating to the depth to the aquifer, the yield of the aquifer, the water availability, the degree of treatment required, etc.
2. Economies to scale in spreading fixed costs over a larger volume of output
3. In an area of slow growth a larger percentage of capacity can be utilized than in areas of more rapid growth
4. Depending upon the quality of the raw water and the nature of the end use, different levels of treatment will be needed

Table 20. Summary of Unit Production Costs for Water Source Options.[6]

Water Source Option	Water Production Range	Unit Production Costs[1] ($/1,000 gallons)
Conservation (indoor)	Variable	$.16 - $.31
Conservation (outdoor)	Variable	$.02 - $.71
Ground Water		
Surficial Aquifer - withdrawal only (no treatment)	3 - 20 MGD	$.02 - $.03
Surficial Aquifer w/lime softening	3 - 20 MGD	$.41 - $.71
Surficial Aquifer w/membrane softening[4]	3 - 20 MGD	$.70 - $.81
Intermediate Aquifer - withdrawal only (no treatment)	3 - 20 MGD	$.04 - $.07
Intermediate Aquifer w/lime softening	3 - 20 MGD	$.43 - $.72
Intermediate Aquifer w/membrane softening[4]	3 - 20 MGD	$.75 - $.83
Floridan Aquifer - withdrawal only (no treatment)	3 - 20 MGD	$.03 - $.07
Floridan Aquifer w/reverse osmosis[4]	3 - 20 MGD	$.73 - $.93
Reclaimed Water	Variable	$.40 - $2.20
Seawater w/reverse osmosis	Variable	$1.71 - $8.77[2]
Storage		
ASR	3 - 20 MGD	$.08 - $.10
Reservoir (4 feet deep)	6,000 acre-feet	$.15[3]
Reservoir (8 feet deep)	12,000 acre-feet	$.12[3]
Surface Water - withdrawal only (no treatment)	Variable	$.02 - $.15[5]
Surface Water w/lime softening	3 - 20 MGD	$.60 - $.89[5]
Surface Water w/membrane softening	3 - 20 MGD	$.81 - $.97[5]

1 All costs are over a 30-year project life. Because of economies of scale, the lower cost represents cost per unit for the greater capacity.
2 Lower cost in the range reflects a high degree of special site-specific circumstances.
3 This represents the cost based on physical volume. Per unit cost for water made available is highly dependent on operational regimes.
4 Deep well injection is used for concentrate disposal.
5 Assumes withdrawal from existing surface water source, such as a canal or existing surface water management system. Cost could be significantly higher if separate storage area is required.
6 These are planning level unit production costs. The relative cost between source options is comparable. However, the unit production costs presented here are not necessarily directly comparable to unit production costs developed in other investigations. To be considered comparable, cost estimates must use the same economic criteria.

Related Strategies

The LWC Water Supply Plan addresses various supply and demand parameters that serve to define the quantity of water that is available for allocation. These parameters are appropriate for use in the CUP Program. Additional LWC Water Supply Plan parameters related to environmental and water shortage are also appropriate for rulemaking and are related to the District's overall water management program, beyond CUP Program considerations. Thus, the plan recommends rulemaking for the purpose of incorporating salient portions of this plan in the CUP Program and other components of District's overall water supply management scheme. Matters that are recommended for rulemaking consideration include (1) level of certainty, (2) resource protection criteria, (3) water shortage triggers, (4) MFLs for the Caloosahatchee Estuary and the LWC aquifer system; and (5) special designation area amendments, including Reduced Threshold Areas (RTAs) and Water Resource Caution Areas (WRCAs).

RTAs are areas of the District where the volume average day demand of usage delineating a general permit from an individual permit has been reduced from 100,000 gallons per day (GPD) to 10,000 GPD. RTAs have typically been designated in resource depleted areas where there is an established history of substandard water quality, saline water movement, or the lack of water availability to meet the projected needs of a region. Based on the results of the LWC Water Supply Plan, it is recommended that the RTA designations (Lee County, coastal Collier County, and the Muse/LaBelle area of Glades and Hendry counties) in the LWC Planning Area and the RTA concept be eliminated in the LWC Planning Area.

WRCAs were formerly referred to as Critical Water Supply Problem Areas and are generally defined as areas that have existing water resource problems or areas in which water resource problems are projected to develop over the next 20 years. Currently, the entire LWC Planning Area is designated as a WRCA in Chapter 40E-23, F.A.C. Based on this assessment and the 2020 projected demands, it is recommended that the agricultural areas of southwestern Hendry County and eastern Collier County be removed from this designation; and that the Caloosahatchee Basin and the coastal utility service areas of Lee and Collier counties remain in this designation as indicated in **Figure 7**. This designation generally reflects the eastern boundary of the 2020 utility service area boundaries westward and the portion of the LWC Planning Area that is within the Lake Okeechobee Service Area. Diversification of supply sources is occurring within some of these areas and it is anticipated these areas will be removed from the designation in the future once sufficient diversification has been realized.

Additionally, the District will coordinate the implementation of the LWC Water Supply Plan with local governments/utilities, the CWMP, the LEC Regional Water Supply Plan, the Southwest Florida Study, the CERP, and other related efforts to promote compatibility.

Technical information generated in the planning process will also be made available to the public. Specifically, the District will make available and maintain the ground water models, data, and other relative information referenced in this plan to the

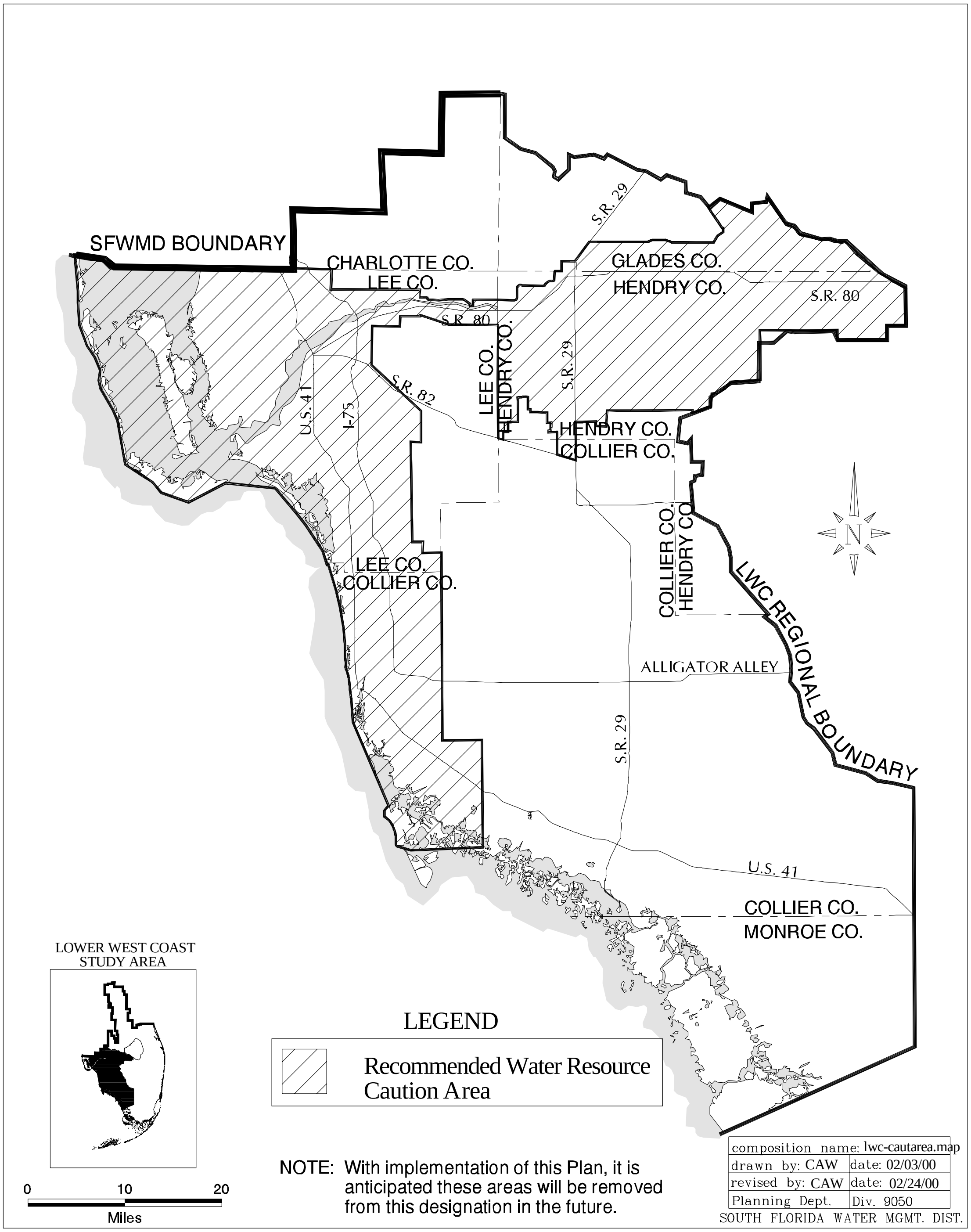

Figure 7. Recommended Lower West Coast Water Resource Caution Areas.

public. It is also recommended the District continue the existing wetland drawdown study that was initiated in 1997.

Related Strategies Recommendations

This section includes those recommended efforts that apply to several of the options or could not be associated with a specific source option.

1. To promote consistency, the concepts and guidelines used in this plan should be incorporated as criteria into the District's water management programs through rulemaking or other implementation processes.
2. The District will conduct a public rulemaking process in accordance with Chapter 120, F.S., for the purpose of incorporating salient portions of this plan into the CUP Program and other components of District's overall water supply management responsibilities. Matters that are recommended for rulemaking consideration include (1) level of certainty, (2) resource protection criteria, (3) water shortage triggers, (4) MFLs for the Caloosahatchee River and Estuary, and the LWC aquifer system; and (5) special designation area amendments, including RTAs and WRCAs.
3. Establish MFLs for the Caloosahatchee River and Estuary and the LWC Aquifer Systems by December 2000 in accordance with Section 373.042, F.S.
4. The District should continue working with other government entities including the legislature, USEPA, and FDEP to accomplish changes in ASR and desalination disposal regulations.
5. The District should continue the Wetlands Drawdown Study and use the knowledge gained during the rulemaking process. The CUP Program should continue to use the existing wetland protection guidelines until such time as rulemaking causes a change.
6. The District will make the ground water models, data, and other relative information referenced in this plan available to the public.

CONCLUSIONS

This section presents the conclusions of the LWC Water Supply Plan, as well as the conclusions of the CWMP.

Lower West Coast Water Supply Plan

The results of this regional assessment indicate that with diversification of supply sources, the projected 2020 water demands in the LWC Planning Area can be met during a 1-in-10 year drought condition while not causing harm to the water resources and natural systems. In the eastern portions (except the Caloosahatchee Basin) of the LWC Planning Area, it was concluded that existing ground water sources are sufficient to meet the 2020 projected demands with minimal potential impacts. Some modifications to wellfield configurations and well operation regimes will need to be done on a project-by-project basis to avoid potential impacts to natural systems and other existing legal users.

In the western portions of the LWC Planning Area, it was concluded that historically used sources of water, primarily the SAS in the urban coastal areas, are not adequate to meet the growing needs of the LWC Planning Area during a 1-in-10 year drought condition due to potential impacts on wetlands and the potential for saltwater intrusion. However, with diversification of supply sources (e.g., Floridan aquifer and increased use of reclaimed water and surface water), it was concluded the projected 2020 water demands can be met. Many of the utilities have begun to diversify supply sources, including using the Floridan aquifer, increasing the use of reclaimed water, and using ASR for storage. The use of reclaimed water and supplemental sources was emphasized to meet the projected irrigation demands in the urban areas, especially along the coast. Additional work is necessary to identify the most effective method to make these sources available for use at the local level, including storage. A regional or subregional irrigation distribution system was discussed and further analysis is supported.

Surface water availability from the C-43 Canal, as well as modifying freshwater discharges to the Caloosahatchee Estuary to maintain a healthy estuarine system, was addressed by the CWMP. The results of the CWMP and the surface water analysis verify that the surface water availability in the C-43 Canal during a 1-in-10 year drought condition under the existing canal and storage network is not adequate to support the projected water supply demands and environmental needs. Sufficient volumes of water to meet the projected demands have been identified, but the timing of water availability has to addressed. These issues will be resolved principally through storage and capture of rainfall/runoff in conjunction with the use of the C-43 Canal and water from Lake Okeechobee. Potential options will be further analyzed in the Southwest Florida Study.

The options in this plan should serve as a menu that local water users can consider to meet their needs. It was concluded that the 2020 water needs of this region (excluding the Caloosahatchee Basin) during a 1-in-10 year drought event, can be met without major water resource development construction projects. However, funding from outside the region may be necessary to implement some projects, such as the regional irrigation system if it is determined to be the most effective method to make irrigation water available for use.

It is recommended the District review existing levels of water quality monitoring for the SAS and IAS in the LWC Planning Area with respect to areas of current and projected land use development, utilization of the aquifer, areas of existing saltwater intrusion, and areas where there is a potential for saltwater intrusion. The District's monitoring program should be expanded where appropriate.

To promote consistency with other District programs, the concepts and criteria used in this plan should be incorporated into the District's CUP Program through rulemaking, such as MFLs, coastal saltwater intrusion prevention, wetland protection, aquifer protection from excessive drawdowns, aquifer monitoring, and protection from contamination. At this time, the resource protection criteria incorporated in this plan appear to be adequate for protecting the resources. However, existing and proposed data collection efforts and studies, such as the District's wetland study, should be continued to refine the criteria. The District should also make available and maintain the ground water models, data, and other relative information referenced in this plan to the public.

There is limited information, data, and in several areas experience regarding the use of the Floridan aquifer in the LWC Planning Area. Many utilities are using, or planning to use, the Floridan aquifer to meet existing and future demands. There is a concern for water quality in the Floridan aquifer, and the long-term sustainability of the Floridan aquifer as source of water. However, based on existing information and experience, significant changes in water quality are not anticipated. It is recommended a Floridan aquifer ground water model be developed for this area to conduct predictive analysis in the future. It is also recommended that a regional Floridan aquifer monitoring network be established to collect the data necessary to establish the relationship between water use, water levels, and water quality.

Freshwater discharges (minimums and maximums) are affecting the health of the Caloosahatchee Estuary, and results in the lose of water from the water supply inventory. The recommendations in the Restudy need to be reviewed as part of the Southwest Florida Study. Also the options explored in the CWMP to address retaining surface water discharges generated within the basin (including structural changes) must continue to be evaluated. The committee also supported establishment of MFLs for the Caloosahatchee Estuary and the LWC aquifer system.

Caloosahatchee Water Management Plan

The CWMP identified the need for storage within the basin using a regional optimization approach with underground storage of such amount that the ASR systems will tolerate extended withdrawals of 220 MGD and 220,000 acre-feet in aboveground storage (reservoirs plus other storage options). The analysis in the CWMP indicates that more detailed evaluation using more site-specific information may result in changes to the sizing and combination of this storage and recommends that the detailed evaluation be continued as part of the Southwest Florida Study.

Five types of potential storage options or components were identified: reservoirs regional and distributed, ASR, backpumping to Lake Okeechobee, in-river storage due to structure S78.5, and water table harvesting. The five storage components were combined into nine alternatives that were evaluated utilizing reduced flows from Lake Okeechobee as modeled in the LEC Regional Water Supply Plan’s 2020 with Restudy simulation. Of these components, model results indicate that backpumping has limited utility or benefit and, therefore, is not practical, based on the assumptions in the CWMP. Addition of a structure in the Caloosahatchee River (S78.5) and water table management showed minimal benefit but may be considered as part of an overall storage strategy. Regional and distributed reservoirs and ASR showed the greatest potential for meeting the storage needs in the Caloosahatchee Basin and are recommended for additional investigation and pilot testing within the basin.

A detailed assessment of the potential storage components is needed to identify a preferred alternative for meeting the demands in the Caloosahatchee Basin in 2020. It is recommended that the detailed assessment be completed as a part of the implementation of the Southwest Florida Study.

The modeling conducted as part of the CWMP to evaluate the performance of various storage components utilized revised Caloosahatchee Basin hydrology and demands from those used in the Restudy. This assessment showed higher demands and lower runoff from the basin, and consequently less water was available to be placed in storage. The CWMP evaluated options that focused on additional storage within the basin coupled with limited water supply deliveries (matching the results of the Restudy) from Lake Okeechobee. Under these assumptions the proposed water supply backpumping option performed poorly. It is recommended that the Southwest Florida Study and the analysis by the CERP Restoration, Coordination, and Verification (RECOVER) process further investigate the recommendations of the CWMP concerning in-basin storage and backpumping for storage in Lake Okeechobee (coupled with reasonable assurances of adequate deliveries from the lake to the Caloosahatchee Basin) to confirm the best combination that meets the cost effectiveness, water supply, and environmental goals recommended in the Restudy and for the Caloosahatchee Basin.

The Southwest Florida Study needs to be completed and implemented to address freshwater discharges to the Caloosahatchee Estuary and increase surface water availability for water use. The recommendations of the CWMP and the Restudy and associated funding should be pursued after detailed modeling is performed.

An evaluation of projected flows to the Caloosahatchee River was conducted via the LEC Regional Water Supply Plan and the CWMP for 1990 base and 2020 base conditions. The results of these evaluations indicate that the proposed MFLs criteria and the restoration base flow needs of the Caloosahatchee Estuary are not being met. Pursuant to the direction provided in Section 373.042, F.S., a recovery plan is provided in the LEC Regional Water Supply Plan. The recovery plan consists of design and construction of enhanced basin storage capacity using surface water, ASR, and reservoirs as described in the Restudy and refined through the CERP and Southwest Florida Study.

Based on the recommended development of water management and storage infrastructure to effectively capture and store the surface water flows in the Caloosahatchee Basin, the projected surface water needs of the basin and the estuary can be met. Supplemental agricultural demands from surface water sources within the basin are estimated to increase from 230,000 acre-feet per year (200 MGD) based on 1995 land use to approximately 320,000 acre-feet per year (285 MGD) on average based on projected 2020 land use. PWS needs from the Caloosahatchee River are projected to increase from 13,000 (12 MGD) in 1995 to 18,000 acre-feet per year (16 MGD) on average by 2020. The environmental needs of the Caloosahatchee Estuary have been estimated at 450,000 acre-feet (400 MGD) while average flows to the estuary are estimated to be approximately 650,000 acre-feet per year (580 MGD) on average. Flow to the estuary in excess of needs can, therefore, be as high as 200,000 acre-feet per year (180 MGD) on average, that is adequate to meet increased demands through 2020. It was also concluded that the evaluated components, once constructed, will be adequate to meet the demands in the basin during a 1-in-10 year drought event.

The CWMP has identified that the future environmental, agricultural, and public water supply needs of the Caloosahatchee Basin and Estuary can be met from a combination of basin storage options with deliveries of water from Lake Okeechobee as identified in the South Florida Water Management Model (SFWMM) based on the "2020 with Restudy componments". The evaluation of storage components conducted as part of the study show that components capable of providing short-term and long-term storage are required. The finding suggests that regional and distributed reserviors, as well as ASR systems would form an integral part of any successful storage development within the basin. A pilot testing program should be developed to verify the feasibility and effectiveness of these storage methods within selected sites in the Caloosahatchee Basin through the Southwest Florida Study.